PETROLEUM PROCESSING

including Petrochemical Processing Section

M A Y 1 9 5 3

Three New Processes

One on lube decolorizing and two on desulfurizing reported to API—p. 683

Hydrogen Blistering

Techniques for preventing this type of metal attack —p. 686

Optical Instruments

How they are being used in processing, in research, in development—p. 694

Routes to Styrene

A petrochemical with an 800% increase forecast by 1975 —p. 724

The Petrochemical Industry

Your 1953 Directory

$750,000,000 worth of new plants now planned or building in U.S. and Canada, bringing total to 271 plants operated by 143 companies . . . . p. 713

ATLAS PROCESSING COMPANY at Shreveport, Louisiana, has recently placed in operation this Hudson-Built benzene recovery plant, the first to recover substantial quantities of natural benzene from liquid hydrocarbons extracted from natural gas. Over 98% of the benzene present in motor fuel base stocks produced in gas processing plants in the Carthage gas distillate field of East Texas is extracted in this unit. The benzene is nitration grade, having a purity of over 99.6%. Hudson is proud of its part in implementing the concept of the Atlas management in this pioneering operation.

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For the Ethyl display will demonstrate why the one thing you needn't worry about is your supply of "Ethyl" antiknock compound. Today "Ethyl" fluid is being manufactured in two entirely separate, integrated

(Continued on next page)

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What's going on here?

(Continued from preceding page)

plants. One in Texas, the other in Louisiana. And there are also storage terminals in California and Delaware—so we can actually supply you from four locations.

We believe this ability to meet your needs from so many directions is one of the most important advantages enjoyed by Ethyl customers. In an emergency our four-point distribution setup could prove to be worth its weight in TEL. And—like Ethyl marketing services, research services and special programs in the farm, bus and truck, and aviation fields—it's all part of the "package" you get when you order antiknock fluid from Ethyl.

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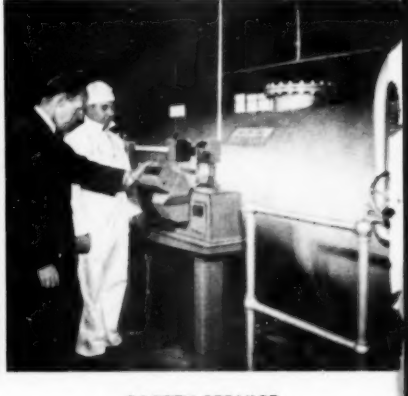

SAFETY SERVICE

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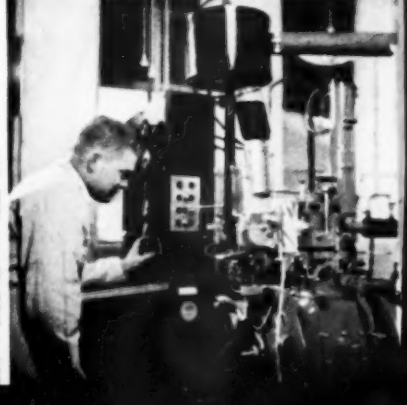

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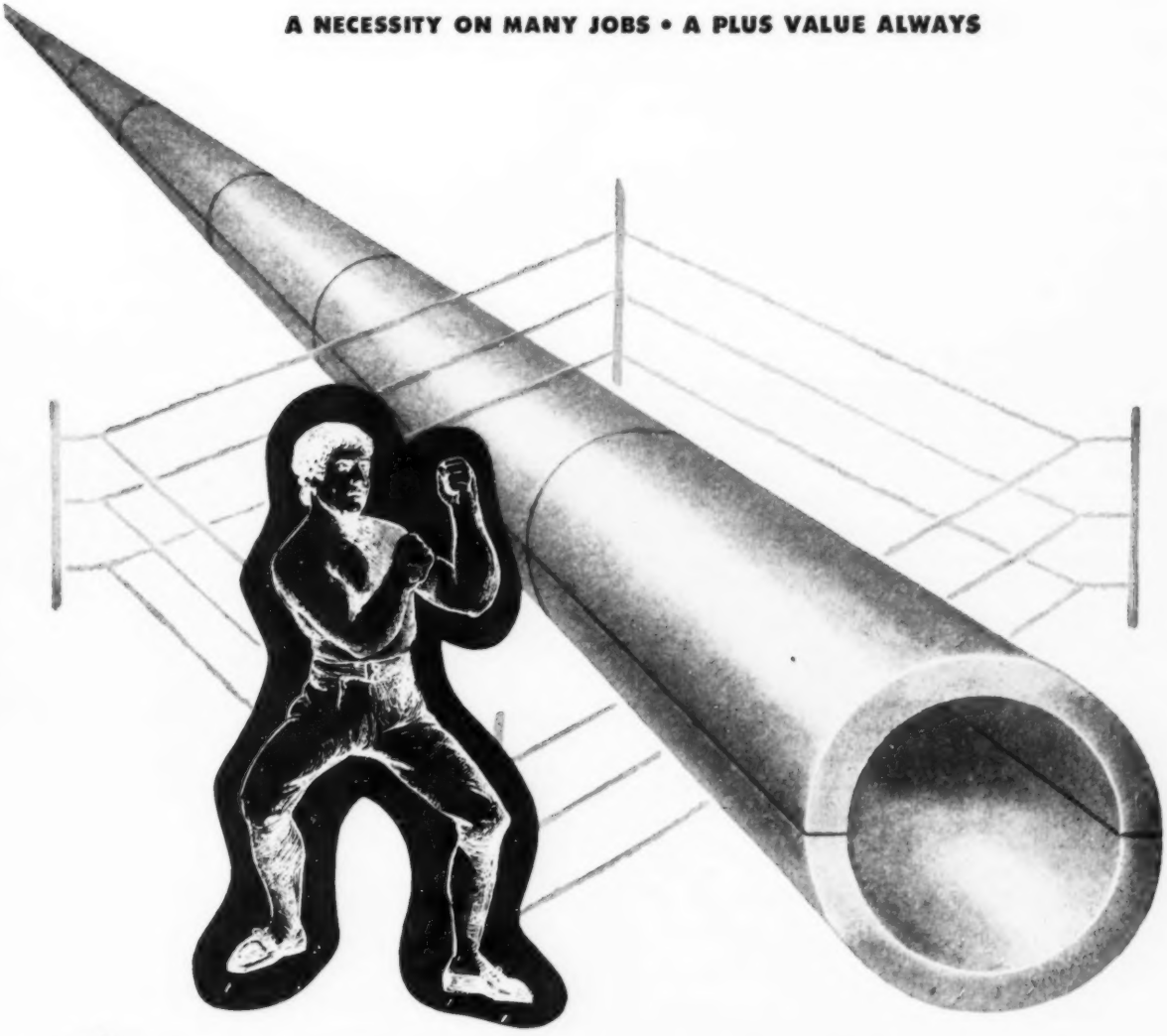

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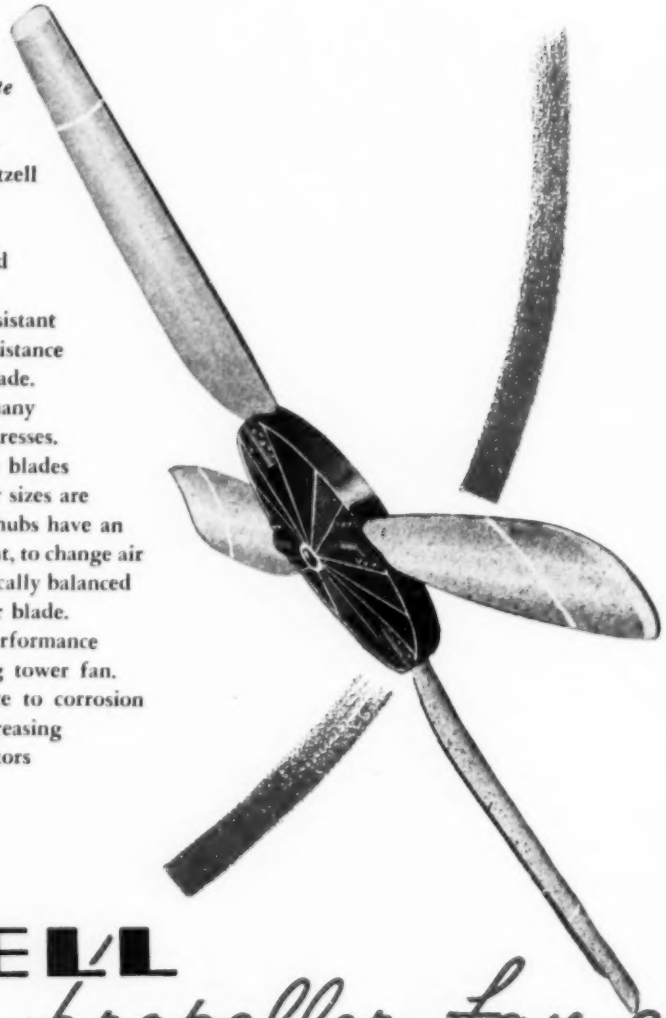

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PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals.

May, 1953
Vol. 8, No. 5

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PUBLICATION OFFICES
1213 West Third St., Cleveland 13, Ohio

Editorial Staff

Virgil B. Guthrie, *Editor*
50 West 50th St., New York 20.

William F. Bland, *Managing Editor*

William C. Uhl, *Equipment Editor*

D. P. Thornton, Jr., *Southwestern Editor*
810 First Nat'l. Bank Bldg., Houston 2.

Frank Breese, *West Coast Editor*
1111 Wilshire Blvd., Los Angeles 17

Andrew R. Patla, *Washington Editor*
1046 Nat'l. Press Bldg., Washington 4.

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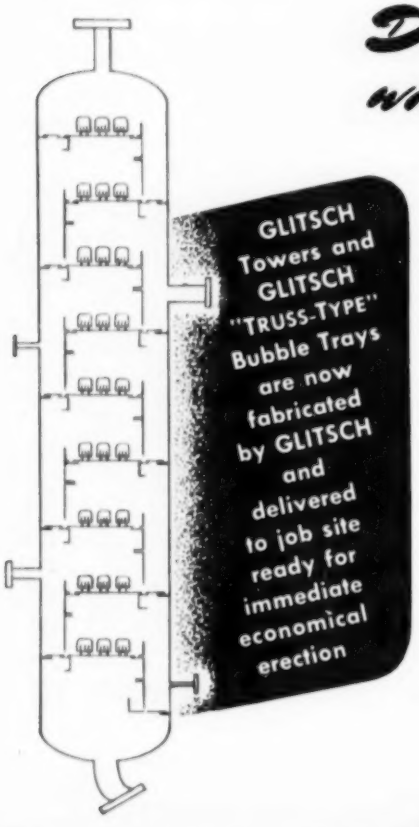

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PETROLEUM PROCESSING

Publisher's Page

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PUBLICATION OFFICES

1213 West Third St., Cleveland 13, Ohio

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Regional Sales Representatives

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"4.5 Min. Can Be a Lot of Help"

The dispatch of information and data is not entirely from PETROLEUM PROCESSING headquarters to its readers. A smaller but important counter-flow brings back from readers mail that is helpful to all of us on its Editorial Staff—comments, contributions, criticisms, suggestions and more. But most important in general are the letters that arrive every day, dozens of them, as part of our regular continuing readership surveys.

Whatever the kind of mail that comes in, it reflects the fact that a good share of PETROLEUM PROCESSING readers are professionally trained scientists and engineers, and experienced operators. The nature of their work calls for logical thinking and accuracy in expressing their ideas, and these traits are evident in their correspondence. Sometimes other traits of the trained scientist show up as, for instance, an engineer's comment on a recent readership questionnaire, "It took me exactly 4.5 min. to fill out."

The readership survey letters make up the most eagerly looked-for mail coming in. The questionnaires go out regularly to a representative sampling of our circulation list, 1000 or sometimes 2000 a month. They ask readers to give their rating on individual articles and features appearing in PETROLEUM PROCESSING. They ask questions to bring out reading habits for PP, for other journals and even the general magazines. The careful compilation and analysis of answers provides the control board from which we work out our editorial programs.

The survey letters are read and passed around by PETROLEUM PROCESSING editors, as well as having their data compiled and analyzed. The occasional side comments, sometimes entirely extraneous to the subject, are nuggets well worth hunting for.

Our readers rate high in their cooperation in these readership 700 replies. That's a high proportion in the experience of most surveys. A recent survey going to 2000 readers, brought in over publishers. We are too modest to believe this high average is just because "our book" is liked. It is also because our readers, confronted today with a large volume of current scientific literature, want us to help them by getting out the kind of journal that will give them the maximum benefit in a minimum of reading time.

Four and a half minutes for the job by one man. If that is a fair average for the time taken by the 700 who answered this particular questionnaire, then PETROLEUM PROCESSING readers jointly gave approximately 52.5 man hours of work to help our editors on the particular problem being investigated. For that engineer's "4.5 min.", multiplied many times, all of us on PETROLEUM PROCESSING are most grateful.

Virgil Guthrie

For the Editors

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What's Happening . . .

Refinery Expansion

. . . **New refinery expansions** to look for, as indicated by rapid tax amortizations announced last month by Office of Defense Mobilization:

American Mineral Spirits, $3,679,200 for aviation alkylate facilities at Toledo, Ohio.

Ashland Oil & Refining Co., $3,435,000 for refining facilities at Catlettsburg, Ky.

Atlantic Refining Co., $4,317,650 for refining facilities in Lea County, N. Mex.

Dakota Oil & Refining Co., $1,210,000 for refining facilities at Minot, N. Dak.

Pan American Refining Corp., $110,000 for refining facilities at Texas City, Texas.

Pure Oil Co., $307,100 for specialized facilities for aviation gasoline at Toledo, Ohio.

Shell Oil Co., $850,000 for refining facilities at Wood River, Ill.

Standard Oil Co. (Ind.), $1,109,000 for refining facilities at Whiting, Ind.

Standard Oil Co. (Ind.), $1,700,000 for aviation alkylate facilities at Casper, Wyo.

Standard Oil Co. (Ohio), $960,000 for refining facilities at Cleveland, Ohio.

. . . **Signal Oil & Gas Co.** has awarded contract to J. P. Pritchard and Co. to engineer, design and construct new natural gasoline plant at Tioga, N. Dak. Construction is expected to start in early summer. Project ultimately will cost $14 million, and will handle 65 million cu. ft. of gas daily.

. . . **Sinclair Refining Co.** will build a new 16,000 b/d catalytic reforming unit at its 105,000 b/d Marcus Hook, Pa. refinery. Construction contract has been let to C. F. Braun & Co., with completion scheduled for the summer of '54. No details on the process to be used have been released, except that "it will employ a new processing method and a platinum catalyst recently developed by Sinclair Research Laboratories and Baker & Co., platinum specialists.

. . . **McMurrey Refining Co.** is undertaking a modernization program at its 12,500 b/d refinery at Tyler, Texas, which will double crude throughput and permit output of substantial amounts of fighting-grade avgas. Now in design stage are 12,500 b/d crude distillation unit, 8,000 b/d decarbonizing unit, 5,000 b/d Platformer, and 1,400 b/d HF alkylation unit. Plant now includes 8,000 b/d Fluid cracker. Contracts have been let to Chemical Plants Div. of Blaw-Knox for crude and feed preparation units, and to Procon for Platformer.

. . . **Standard Oil Co. of Calif.** has let contract to Fluor Corp. for construction of a new 40,000 b/d fluid catalytic cracking unit at its El Segundo, Calif. refinery. Fluor will also build an addition to plant's alkylation unit and make alterations to naphtha rerun stills—all part of a $20 million expansion project the company announced last fall. Another contract was let previously to M. W. Kellogg Co. for 52,000 b/d vacuum flasher. Completions are scheduled for '54.

. . . **The Texas Co.** will nearly double the present 8,500 b/d capacity of its Amarillo, Texas refinery in a modernization program estimated to cost "several million dollars." The project includes combination 15,500 b/d crude distillation and 3,600 b/d delayed coking units, a 6,000 b/d (fresh feed) Orthoflow Fluid catalytic unit, and catalytic polymerization. Contract has been let to M. W. Kellogg Co. and construction is expected to be started this summer.

. . . **Need for further lube facilities** has been questioned by A. W. Scott, president of National Petroleum Assn. Petroleum Administration for Defense has set a goal of 28,000 b/d additional lube facilities by end of '55. According to Scott, that would bring capacity (allowing for retirement of old equipment) up to 194,000 b/d, which he says is 26% more than the average demand for lubes which PAD has estimated for the next three years.

. . . **Pan American Refining Corp.** may soon start construction of a new 25,000 b/d refinery costing around $20 million on the East Coast. Company has three sites under consideration—near Pedricktown, N. J., on the Delaware River; Talbot County on the Eastern Shore of Maryland; and Portsmouth, R. I., on Narragansett Bay near Providence.

Petrochemicals

. . . **Over 60 new petrochemical plants** are now under construction or in the planning stage, according to a survey of the industry just completed by the editors of PETROLEUM PROCESSING. Based on the survey, a new directory of petrochemical operations in the U.S. and Canada has been compiled—and lists 143 companies and 271 plants—including the ones under construction or planned. The directory is published in this issue—beginning on pg. 713.

. . . **M. W. Kellogg Co.** has established a special division devoted exclusively to the process design of plants for the petrochemical and chemical fields. The company also plans to further increase its activities in these fields by "additional emphasis in its Research and Development Dept." and by continuing "to acquire rights for new chemical processes which supplement designs already developed by the company."

. . . **Sinclair Refining Co.** will increase petrochemical activities at Marcus Hook, Pa. in connection with its new 16,000 b/d catalytic reformer—scheduled for completion in mid-'54. Facilities will be expanded to produce aromatics, including toluene and xylenes. Company is presently producing cresylic acids, propylene tetramer and sulfur at Marcus Hook.

. . . **Standard Oil Co. of Calif.** has let initial contracts for a new paraxylene plant to be built at its El Segundo, Calif. refinery. Plant itself will be con-

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

structed by Fluor Corp., with off-site facilities built by Macco Corp. Company recently completed an aromatics recovery unit at the refinery, and is also building a cumene plant.

. . . **Shell Chemical Corp.** has opened a new storage and shipping terminal for its chemical products at Industry, Pa., near Pittsburgh. Terminal includes over 2½ million gal. of storage facilities for acetone, alcohols, ketones and other petrochemicals—most of which are barged up from Shell's plant at Houston. Deliveries will be made by tank truck, tank car and drum over a 150-mi. radius.

. . . **Spencer Chemical Co.** plans to enter a new phase of the petrochemical field—polyethylene. Company will build a plant to produce 45 million lbs. of this material annually at Orange, Texas, puchasing ethylene via pipeline from Gulf's refinery at Pt. Arthur. Imperial Chemical Industries Ltd., holder of basic patents on polyethylene process, has licensed Spencer to operate under its patents. New facility is expected to be in operation by spring of '55. Spencer's previous petrochemical activities have been confined to using natural gas for making ammonia, methanol and related products.

. . . **Output of high-grade naphthenic acid** could be practically doubled by U.S. oil refiners in event of an emergency, according to a survey by Petroleum Administration for Defense. Survey, covering about 72% of total U.S. refining capacity, showed that current annual production of naphthenic acid of 180 acid number or higher is about 33,600,000 lbs. If necessary, the refineries could produce more than 32,500,000 lbs. of additional acid each year. Usual source of the acid in refinery operations is to recover it from caustic solutions that have been used in washing straight-run distillate fuel oils.

Markets, Prices

. . . **Summer discount on heating oils** in the East and "unseasonal strength" in heavy fuel prices at seaboard refineries were the main price and marketing developments during April. A rainy, windy month helped work off some of the excess inventories of No. 2 fuel, and also tended to delay start of the so-called "gasoline season." Nevertheless, inventories of gasoline early in the month topped out at about 162 million bbls. (API basis) and refiners generally reported increased shipments.

. . . **Heavy fuels were strong at seaboard refineries,** with prices up 10c a bbl. to $1.60 at the Gulf for cargo lots, and generally higher in same amount along Atlantic Coast. New York Harbor barge price was firm at $2.10. At Chicago, on the other hand, both heavy fuel and distillate prices were lower, 0.25c and 0.125c per gal., respectively.

. . . **Principal development on distillates**, however, was 0.5c summer-fill discount plan announced by majority of marketers along Atlantic Seaboard to stimulate shipment from primary to secondary storage during the months immediately ahead. Esso Standard was first company to make a general discount during the period April 27 through Sept. 30 to buyers of kerosine, No. 2 fuel, and Diesel oil. Esso estimates that requirements for middle distillates in the winter 1953-54 will "reach an all-time peak, continuing the general trend toward seasonality of demand." Company also believes that in addition to summer fills the industry will have to build up distillate stocks east of the Rockies between now (Apr. 24) and the beginning of winter at a rate of more than 3 million bbls. per week.

. . . **Specialty price news** included offerings of solvent refined bright stock, 95 V. I., as low as 18.33c, FOB ship at the Texas Coast, or about 8c/gal. below similar offerings late in '52.

LP-Gas prices slipped below "ceiling" levels, and producers starting shipping material to underground storage—about a month earlier than a year ago because of a mild winter in the Southwest.

Wax prices were firmer. Natural gasoline prices were unchanged at levels on par with prices quoted last summer.

Industrial Mobilization

. . . **Continuation of an independent PAD** in Interior Dept. apparently depends on willingness of industry to supply top-caliber personnel. Interior Secretary McKay has stated flatly that PAD will be continued as-is after June 30, except on a reduced basis in line with ending of materials controls. He has indicated, however, that drop in caliber of PAD officials might make him receptive to idea of placing PAD functions under Interior's Minerals Division.

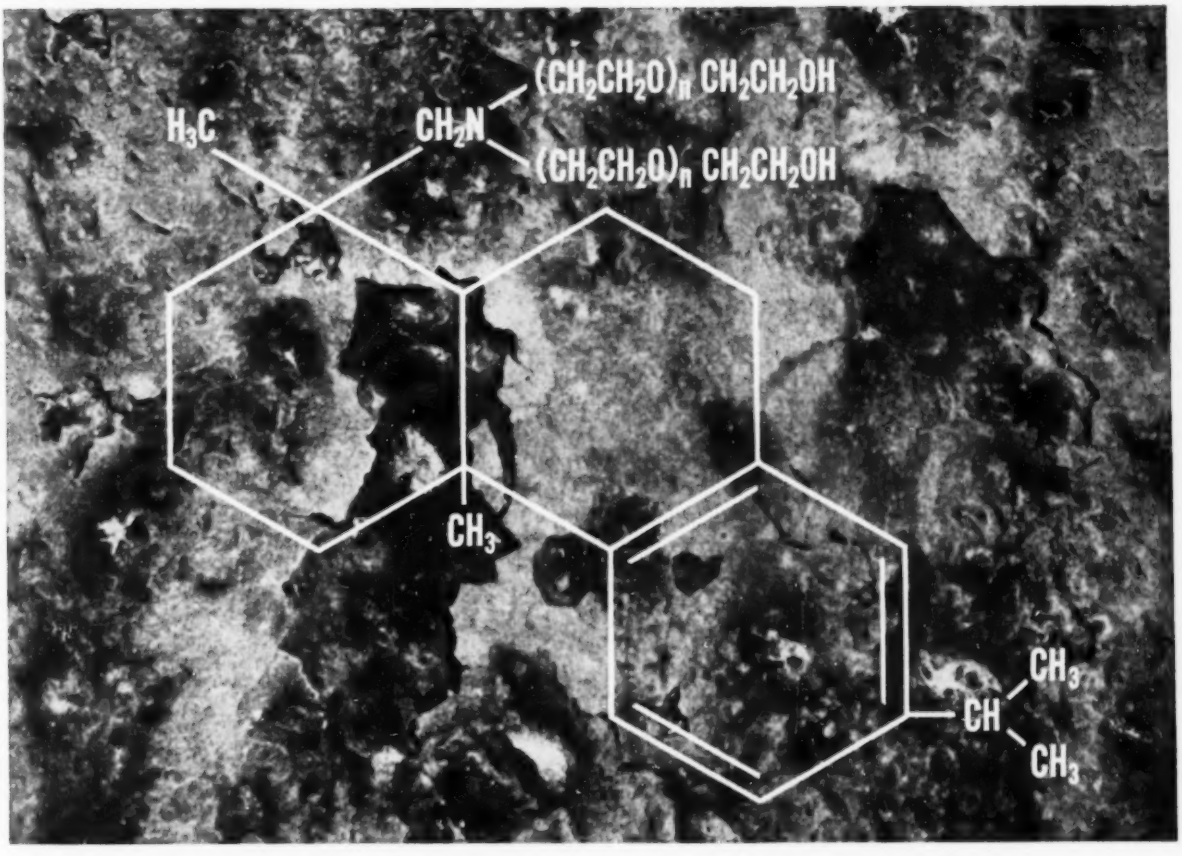
. . . **Alkylate expansion goal of 30,000 b/d** has been set by Office of Defense Mobilization, same as target previously established by PAD and ASPPA. ODM says its goal is in addition to plants already built or under construction. Reportedly, 6,600 b/d of new capacity is now in negotiation stage, leaving 23,400 b/d still to be met.

. . . **Materials situation is now good,** according to PAD's materials director, Harris Bateman. He reports that former "flood" of requests for aid has dwindled to a "thin trickle" now. Even supply of nickel-bearing stainless steel appears reasonably good, he says.

Miscellany

. . . **Shell's new hydrodesulfurization process** is being made available through the Lummus Co. Particularly attractive features of this process are that feed stocks need not be vaporized, heavier charge stocks can be desulfurized, and longer on-stream periods are claimed. (The process is described in detail in this issue—p. 683.)

. . . **Bureau's synthetic fuels research work** is being sharply curtailed under new administration. Present indications are that coal hydrogenation and gas synthesis demonstration plants at Louisiana, Mo., will be shut down, and possibly sold, but that Rifle, Colo. oil-from-shale demonstration plant will be kept in operation for at least another year. Shale oil laboratory at Laramie, Wyo., may also be kept in service.



ACID CORROSION IN REFINERIES CONTROLLED WITH POLYRAD

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Internal corrosion and plugging of refinery equipment are controlled with Polyrad 1110-A, a new inhibitor developed by Hercules research. Now in use in a number of refineries, Polyrad helps maintain throughput, increases heat transfer, reduces metal loss, and cuts shutdown time and repairs.

Polyrad is a derivative of an organic amine. Its chemical nature is shown above. When injected into refinery equipment, it forms a molecular film that shields metal surfaces from hydrogen-ion attack by organic and inorganic acids.

Polyrad 1110-A, used in refinery equipment, is unique in that it has a detergent action. It loosens iron sulfide and other scales, permitting them to be dispersed in the fluid stream and removed at the water separator or product receiver.

This new inhibitor is designed to function efficiently under acid conditions. For example, at low concentrations it gives better than 99 per cent protection to mild steel immersed in strong hydrochloric acid. It can also be used in conjunction with ammonia or other alkalies. Polyrad has proved to be effective up to 500°F.

Polyrad 1110-A is readily available. Stocks are carried at convenient locations for prompt shipment. For further information, send for Technical Service Bulletin No. 189.

Naval Stores Department

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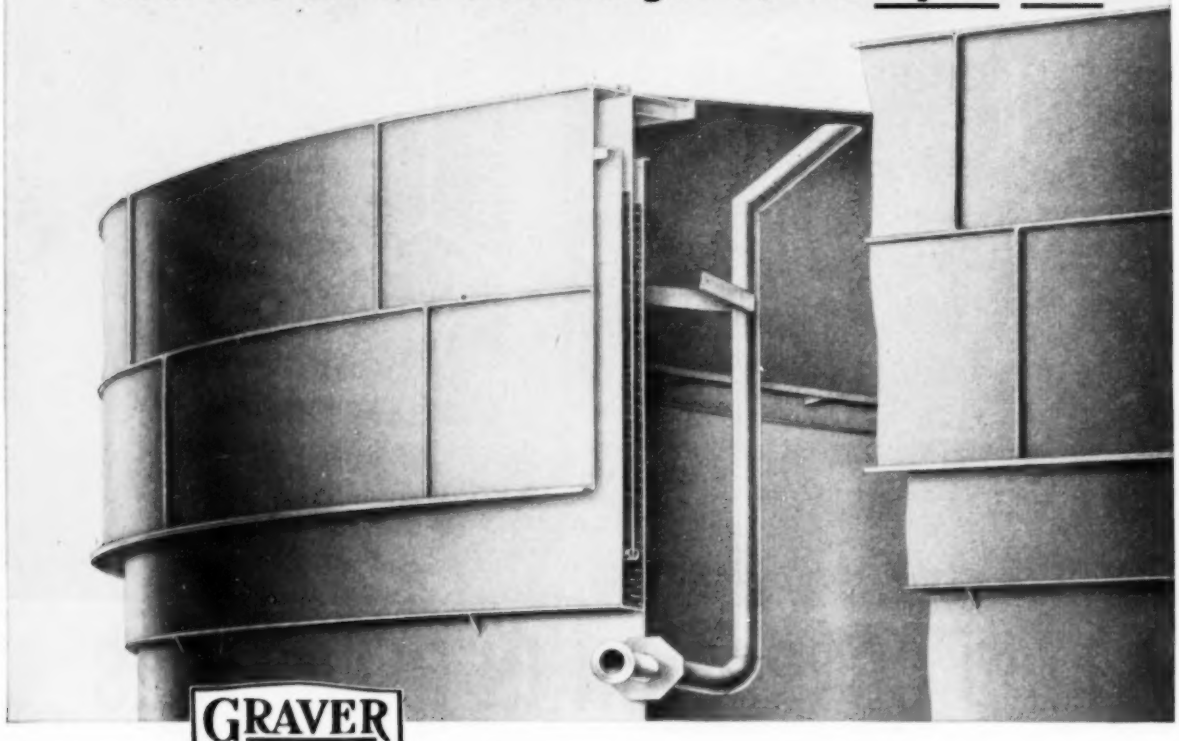
(To obtain more data on advertised products see page 768)

ONLY THE **GRAVER** EXPANSION ROOF

...offers all the advantages of the liquid seal



Positive seal protects under all conditions
High operational efficiency shown over a decade

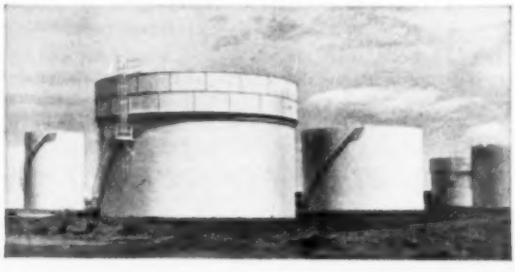
...Low maintenance equals that of cone roof tankage
Easy manifolding affords terminal-wide protection

...Accurate gauging obtained through vertical lift
Unique stabilizing device means trouble-free action

...Removable weather hood facilitates inspection
Simple installation converts existing tankage
Underwriters' Laboratories asserts Graver Expansion Roof conducive to reduction of fire hazards

INTERNATIONAL PETROLEUM EXPOSITION TULSA MAY 14-23

Available upon request is a 16-page booklet describing in full the operation of this exclusive Graver design. Graver Expansion Roof tanks have been protecting volatile elements of gasoline at important installations since 1939.



GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA
NEW YORK • CHICAGO • PHILADELPHIA • ATLANTA
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Aromatics and Olefins from Shale Oil Now Seen as a Possibility

SUCCESS with an improved shale oil retorting method in the form of a continuous process by the Bureau of Mines at Laramie, Wyo., has included extraction not only of high quality gasoline and oil products but also of good yields of aromatic and olefinic chemical by-products.

A flexible process, the retorting time and temperature variables can be adjusted to control both product quality and type, the Bureau has found.(1) Studies were made in a pilot plant in which feed rates up to 500 lb/hr. of oil shale have been attained. Crude-oil yields from a so-called 30-gal./ton shale (30 gals. hydrocarbons per ton of shale) have reached 21 gals./ton. Naphtha yields as high as 6½ gals./ton have been obtained. The noncondensable gases have a high ethylene content and contain considerable quantities of polymerizable olefins, it was said.

The aromatics capable of being produced include benzene, toluene, and small quantities of xylenes and naphthalene. The olefins are ethylene, propylene, butylene, butadiene, and others.

A high temperature (900 to 1800° F.), "entrained solids" techniques is used in the new continuous process. It is said to complete in three seconds the retorting process that once required hours in batch-type units. Particles of oil shale, crushed to ¼ in. or smaller, are picked up by superheated steam and carried through the retort tubes for virtually instantaneous extraction of the oil. Gases other than steam can be used as the entrainment medium.

One disadvantage admitted by the Bureau is the finely crushed shale. Crushing is expensive, but it is possible that the high value products would support costs of preparing such shale in an independent operation.

A major oil or chemical company, whose identity was not disclosed, is investigating the possibilities of using oil shale as source of chemicals now in demand, according to the Bureau.(2) Union Oil Co. of California is known to have been carrying on extensive research work with oil shale retorting.

—W.C.U

(1) Synthetic Liquid Fuels, Annual Report of the Secretary of the Interior for 1952, Part II, Oil from Oil Shale; Bureau of Mines Report of Investigations 4943.
(2) *Wall Street Journal*, April 7, 1953.

Stiff Taxes Make Money Poor Lure For Future Executives

IT WILL TAKE more than big salaries to bring potential businessmen of tomorrow into responsible executive jobs. With chances for substantial lessening of taxes "remote", today's business leaders must stress the "professionalism" and "prestige" of their calling to insure guidance and expansion for our industrial future.

Those are the opinions expressed by Crawford H. Greenwalt, du Pont's president, before the Executive Club of Chicago, May 1.(1)

Mr. Greenwalt declared that half our present national working force is making and selling products unheard of in 1902. He predicted a similar expansion in the second half of the century, with this heavily implied if: The flow of leadership qualities into business must be accelerated if industry is to keep step with scientific advancement.

Granting that money still has a "wide circle of admirers", he said present and predicted future tax structures leave a wide gap between executive salary and actual income. If money can't be used as an attractant, Mr. Greenwalt asked, then what?

The most workable solution, he found, is to enhance the prestige of an executive career. He admitted that wasn't an easy task, since "the more able the executive, the less he stands out." The path to Mr. Greenwalt's podium of prestige can't be reached by synthetic honors or even public acclaim. Tomorrow's young business executive must feel, within himself, that the job he is doing is a true art, that his work is the vital cog between technology and the consumer and that the worth of his calling is unquestioned.

If this individual positiveness can be attained, Mr. Greenwalt believes there need be no gray hairs grown over America's commercial future. —W.N.T.

(1) "We Are Going To Need More Executives," Crawford H. Greenwalt, president, E. I. du Pont de Nemours & Co., presented before Executives Club of Chicago, May 1, 1953.

Petroleum May Yet Supply Materials For Future Synthetic Lube Oils

AS SYNTHETIC lubricating oils come into use to meet performance conditions which straight petroleum lubricants cannot satisfy, petroleum will still be the source of the chemicals from which at least certain types of synthetic lubes are derived.

An ester-type synthetic jet engine lubricant, required to meet the needs of the new high power jet engined aircraft, was recently announced by the Standard Oil Development Co.(1) Aside from performance characteristics, other advantages are seen in petroleum as a starting material for this lubricant.

Petroleum would always be widely available for this use, it is pointed out, whereas alternative chemical sources might be scarce in times of national emergency. The ester type oil derived from petroleum would be lower in cost than those from other sources. The synthetic jet engine lubricants developed to date by SOD have been blends of esters from other sources but, say the authors: "It is believed that the petroleum-source synthetic products will eventually be the most widely used type."

Even present day jet engines, delivering the equivalent of 9-10,000 hp when flying at modern high speeds, have developed entirely new lubrication problems. Highly loaded gears and bearings must be lubricated at speeds as high as 10,000 rpm. In the latest jet engines, the temperature level at the rear bearing, located near the actual combustion zone, may exceed 450° F.

On the other hand, at high altitudes and in Arctic climates, temperatures in the range of −65° F. may be encountered in oil systems of jet engines during starting. The lubricant must be fluid enough, at this

Table 1—Properties of Ester Type Synthetic Oils

Property	Synthetic Oils "A"	Synthetic Oils "B"	Synthetic Oils "C"	Mineral Oils 1010 Jet Engine Oil	Mineral Oils 1100 Piston Engine Oil
Viscosity at 210° F., cs.	7-9	3-6	3-1	2-5	20-5
Gear scuff load, per cent. of Grade 1100 oil.....	105	60	45	<15	100
Flash point, ° F.	450	430	400	295	485
Relative evaporation rate at 400° F. per cent. of Grade 1010	2	3	10	100	1
Oxidation-corrosion stability at 347° F.	Stable, non-corrosive.	Stable, non-corrosive.	Stable, non-corrosive	Unstable, corrosive.	Unstable, corrosive.
Temperature range for 5,000 to 20,000 cs. visc., ° F.	—25 to	—55 to	—60 to	—45 to	+5 to

low temperature, to pump through the oil system, and still must not evaporate or decompose at high temperatures to give excessive oil consumption. Table 1 shows the properties of the ester-type synthetic jet engine oils, compared with the conventional mineral base oil, MIL-O-6081A Grade 1010 jet engine oil and MIL-L-6082A Grade 1100 piston engine oil.

Many will believe, with the Standard Oil Development Co. scientists, that this synthetic oil heralds the beginning of new concepts in lubricant production and performance—but it is just the beginning. —V.B.G.

(1) "Performance of Turbo Engine Synthetic Oils" A. B. Crampton, W. W. Gleason, W. E. Lifson and E. F. H. Pennekamp, Esso Laboratories, Research Division, Standard Oil Development Co. Presented before National Fuels and Lubricants Meeting, Society of Automotive Engineers, Tulsa, Nov. 6-7, 1952.

Changing Petrochemicals Market Requires Constant Watching

AN UNBALANCED market situation in ethylene glycol—current production rates becoming greater than estimated demand—is a picture being given careful scrutiny by the petrochemical industry. Expansion of manufacturing facilities is being viewed with increased caution.(1)

For many years the glycol product enjoyed a growing market. Production went for 150 million lbs. in 1941 to nearly 600 million in 1951 and always found ready users. Estimates of consumption now indicate that the year-end rate reached last year of 810 million lbs. annually may not find a market. A drop in price has indicated unbalanced supply and demand. And estimates for demand for the next decade further indicate a levelling off.

For example, Kuhn(2) has estimated ethylene glycol consumption in 1962 at about 800 million lbs. The President's Materials Policy Commission sees about the same kind of figures—670 million lbs. of the glycol to be used in 1960 (not including uses in synthetic fibers, solvents and plasticizers which could add about 150 million to the figure).

A further illustration of the present character of the market and its future can be found in the DPA goals, the current yard stick for expansion. In contrast to the estimates cited above, DPA goals are set at 850 million lbs. by 1955. As of December 15, 1952, all of this capacity was accounted for by both rapid tax amortization and unassisted expansion. It is further indicated that indirect expansion stemming from the DPA goal could increase capacity to 900 million lbs./year.

Inasmuch as the present and indicated supply of ethylene glycol appears to be in excess of current and potential demand, steps are being studied to correct this situation. Consideration is being given to the possibility of curtailing new facilities wherever possible until demand trends again show a need for more expansion.

New uses for the glycol may be developed, even though it does not appear to be as susceptible of chemical utilization as phenol. Some researchers may turn to study of ethylene oxide, the precursor of the glycol, as an alternate to new uses for the glycol. Here again, the picture is very hazy and obscured because of attention being paid to acetylene as a replacement for ethylene oxide as a starting material for some current chemical commodities.

The one definite point brought out by the changing market scene is that private enterprise and competition of the kind found in petrochemical processing is geared to find its own answers quickly whenever the need arises. W.C.U.

(1) Statement from the Commercial Chemical Development Association, by Wayne E. Kuhn, The Texas Co. and president-elect of CCDA, March 23, 1953.
(2) "Ethylene Petrochemicals, Today and Tomorrow," Wayne E. Kuhn and J. W. Hutcheson, The Texas Co. PETROLEUM PROCESSING, October and November, 1951, pp. 1101-1111 and 1236-1243.

Definitely a Big Business, Power From Atoms Still Faces Obstacles

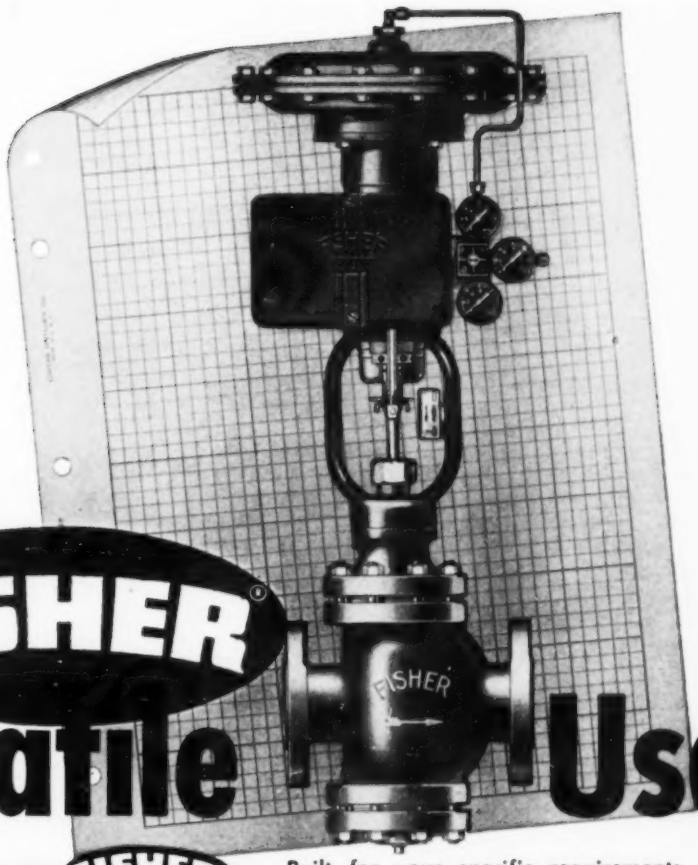
MINDFUL of the fact that heat energy available from atomic materials is 23 times the heat energy of the world's fossil fuel resources,(1) producers of energy from these sources—such as petroleum processors—are remaining alert to developments in atomic power.

What are some of the more recent authoritative predictions as to nuclear power? For one thing, power reactors will be one of the predominant forms of peacetime civilian atomic fission development, even though the government plants devoted not only to power but also to weapons, isotopes, etc. will still be running full blast for at least 10 and perhaps 20 years.(2)

Five years from now there will be at least one industrial power reactor. Ten years hence this figure will rise to about six, representing a total investment of approximately $500,000,000. Reactor developments will fall into three general categories: 1) central power station type in the 100,000 KW class, costing $25 million to $100 million; 2) so-called research reactors in the 10,000 to 50,000 KW class, costing around $5 million; 3) low power jobs running 10 to 1000 KW, costing anywhere from $50,000 to a million or more.(2)

Key factor is of course the economic angle in atomic power's potential competitive position. Fossil fuel sources are still cheaper. If fission plants' wastes—highly radioactive materials with safety headaches involved in their disposal—can be developed as a source of revenue, the economic situation can change rapidly and materially. —W.C.U.

(1) "Atomic Power and Electric Power," Walker L. Cisler, President, Detroit Edison Co., presented at 20th annual meeting, Southeastern Electric Exchange, Boca Raton, Fla., March 23-25, 1953.
(2) "Present and Future Uses of Atomic Energy in Industry," Jerome D. Luntz, Editor, *Nucleonics;* presented at manufacturing conference of American Management Association, New York, April 8-10, 1953.



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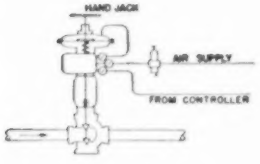
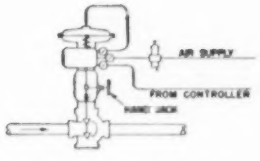
TYPICAL EXAMPLES OF FISHER DIAPHRAGM MOTOR VALVE WIDE RANGE ADAPTABILITY

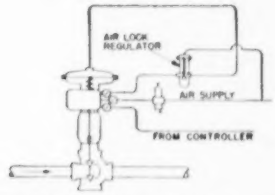
Built for your specific requirements, Fisher Diaphragm Motor Valves are manufactured to handle pressure conditions up to 10,000 pounds, for high pressure drops and are available in metals for highly corrosive service and alloys for high temperature work.



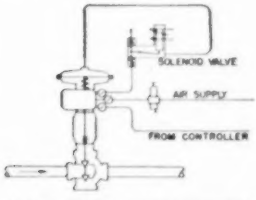
DMV with Hand Jack Operator. Allows for manual operation against spring action. Limits travel of valve. Example — Maximum opening in spring opened valve. Minimum closing in spring closed valve.



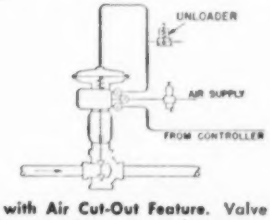
DMV with Continuously Connected Handwheel. Operator can open or close valve against controller action. Can operate valve manually if operating medium fails. Can set maximum opening or minimum closing of inner valve.



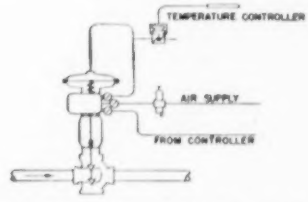
DMV with Air Lock. Should operating air supply fail, air lock regulator closes, locking pressure on diaphragm — valve remains at last position until operating air supply is re-established.



DMV with Remotely Actuated Electric Solenoid Trip Out. Valve may be fully opened or closed by unloading operating pressure from diaphragm by solenoid operation. Solenoid is actuated from manual switch or an electric tie-in circuit.



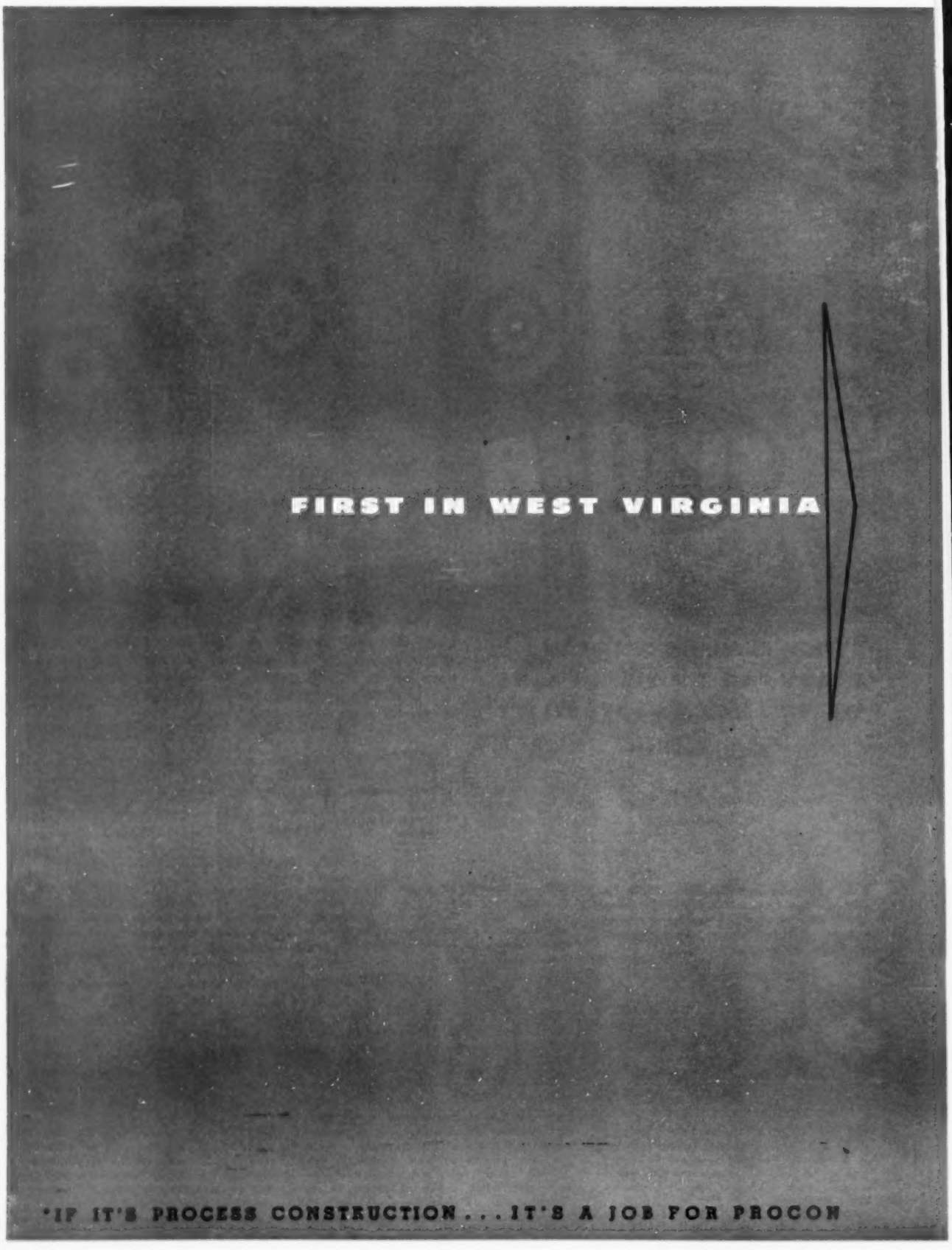
DMV with Air Cut-Out Feature. Valve member becomes inoperate, subject to manual handling to re-establish operation. When controller removes air from diaphragm, UNLOADER opens. Valve remains in this position — UNLOADER orifice is too large to allow air pressure to be re-established.

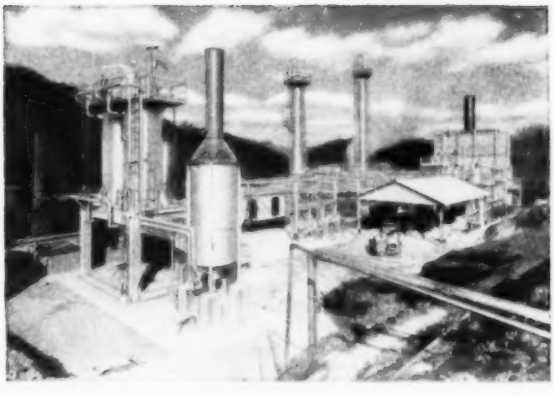


DMV — with Auxiliary Controller Over-ride. An auxiliary controller, such as temperature, placed in operating air line to diaphragm — can over-ride action of main control function by unloading diaphragm and taking over functional operation of DMV.

FISHER GOVERNOR COMPANY • MARSHALLTOWN, IOWA

(To obtain more data on advertised products see page 768)


FIRST IN WEST VIRGINIA
"IF IT'S PROCESS CONSTRUCTION . . . IT'S A JOB FOR PROCON



PLATFORMING UNIT
BUILT BY PROCON
FOR ELK REFINING CO.

A new Procon-built UOP Platforming unit is successfully operating at the Falling Rock refinery of Elk Refining Company. This new unit — the first in West Virginia — is the latest addition to the growing list of processing facilities constructed by Procon and now operating in refineries of both major and independent companies . . . another example of Procon success in handling a broad range of jobs throughout the nation and overseas.

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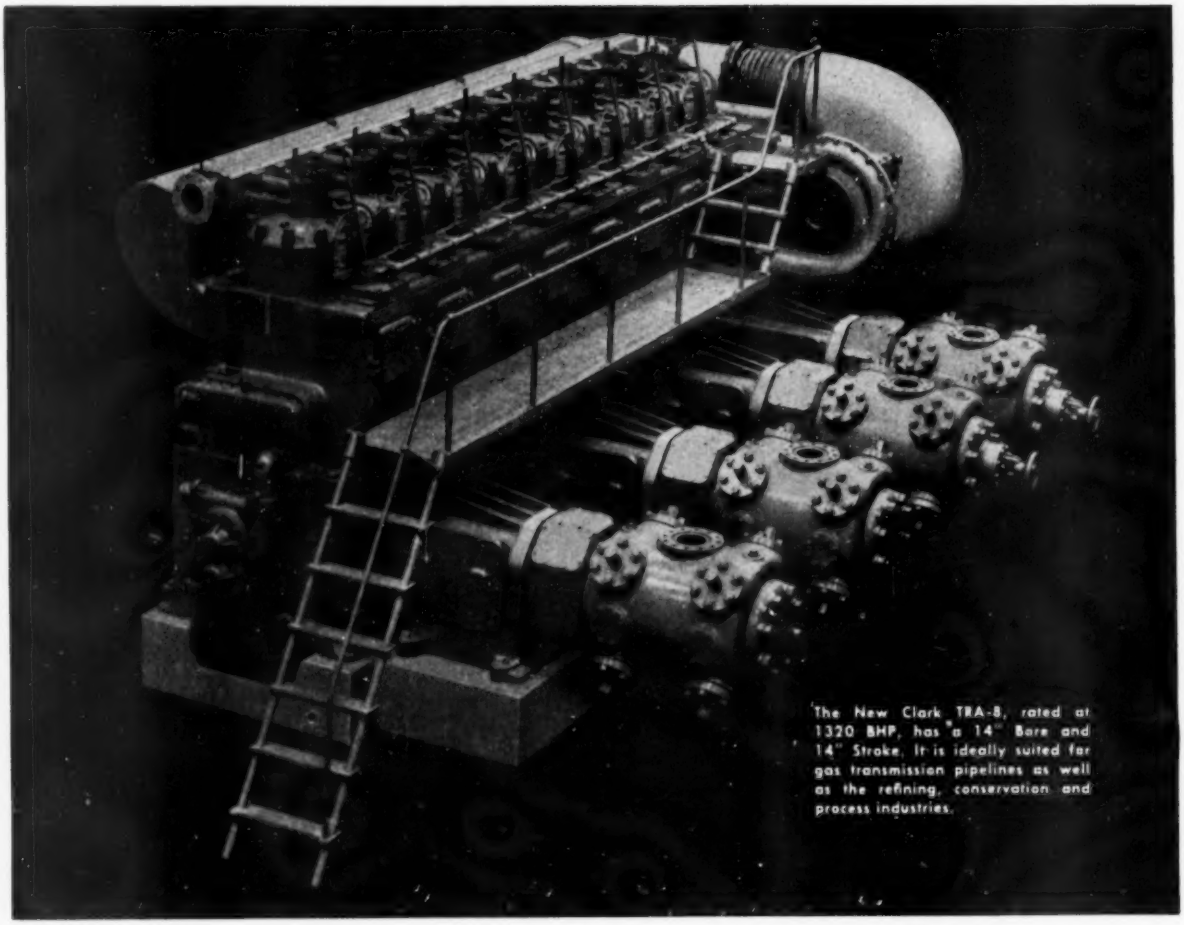
ITS HERE! a

The NEW Clark 2-Cycle



The New Clark TRA-8, rated at 1320 BHP, has a 14" Bore and 14" Stroke. It is ideally suited for gas transmission pipelines as well as the refining, conservation and process industries.

Clark Continues to Set the Pace in Compressor Progress

revolutionary compressor development!

Turbo-Charged "Right Angle"

It's here — after seven years of intensive development. Clark revolutionizes compressor design with the first 2-Cycle Turbo-Charged Gas Engine Driven Compressor . . . the TRA. Another Clark first! A precedent-shattering development that makes possible —

50% MORE POWER
Developing 1320 bhp, the TRA-8 delivers 50% more power than any comparable compressor, with *no* encroachment on overload carrying ability.

SHARPLY REDUCED FUEL CONSUMPTION
The TRA is conservatively rated *and guaranteed* to burn substantially less fuel than *any* gas engine driven compressor now built.

25% LESS COOLING WATER LOAD
(Including scavenging air intercooler load.) Vast amounts of waste heat are recovered from the exhaust gases by the Clark Turbo-Charger and are converted to useful work.

FLAT FUEL CONSUMPTION CURVE
Fuel consumption remains practically constant over a wide range of load conditions.

QUIET
Energy goes into power, rather than noise. Much quieter than a conventional gas engine driven compressor. No exhaust pulsations.

UNPRECEDENTED RUGGEDNESS
Tremendous stamina, unapproached by any other compressor design. Conservative BMEP rating.

COMPACT IN-LINE DESIGN
Very economical of floorspace, foundations and building requirements, yet highly accessible.

•

The Clark TLA, with 17" bore and 19" stroke, is also available when units of even greater horsepower than the TRA are required. For complete engineering details — the facts behind this revolutionary compressor development — see your nearest Clark representative and write for Bulletin 130.

CLARK BROS. CO. • OLEAN, N. Y.
DIVISION OF DRESSER OPERATIONS, INC.
SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

CLARK compressors

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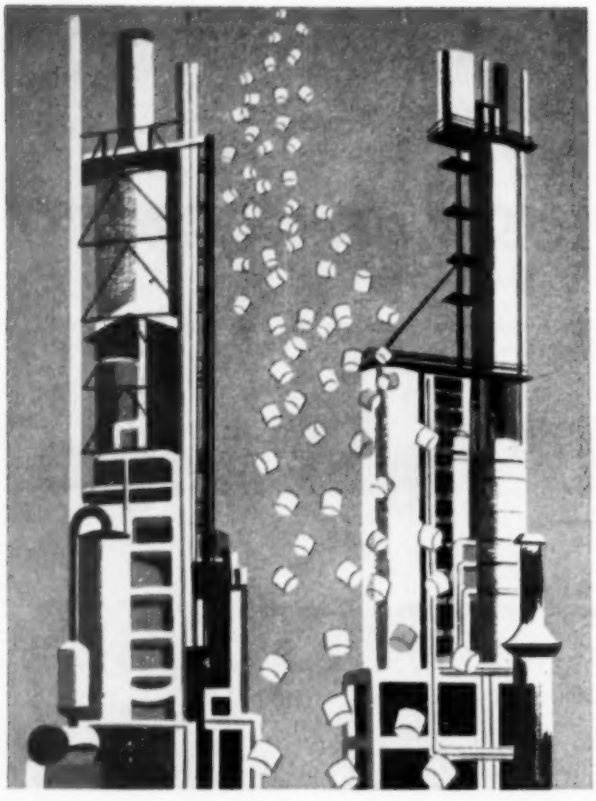

Filtrol SR Pelleted Cracking Catalyst

FOR HOUDRIFLOW AND AIR-LIFT TCC UNITS. FILTROL SR CATALYST IS NOW BEING USED SUCCESSFULLY IN COMMERCIAL OPERATION. SR CATALYST YIELDS HIGH OCTANE CATALYTIC GASOLINE AND CAN BE USED PROFITABLY IN CRACKING A FULL RANGE OF GAS OILS, INCLUDING HIGH SULFUR BEARING STOCKS. SHOWN BELOW ARE THE CHARACTERISTICS OF SR CATALYST AS COMPARED TO REGULAR FILTROL TCC PELLETED CATALYST USED SO SUCCESSFULLY SINCE 1943:

GRADE	FILTROL TCC (23)	FILTROL SR (63)
ACTIVITY BY CAT A	40	36
CPF	1.0	1.0
PELLET DIAMETER	0.19"	0.19"
MESH 3-6 MESH	99%	98.5%
HARDNESS	70	93 MIN.

TYPICAL YIELDS OF SR AS COMPARED TO REGULAR FILTROL TCC ARE:

GRADE	FILTROL TCC (23)	FILTROL SR (63)
CYCLE OIL, VOL. %	48	48
DEBUT. GASO., VOL. %	42	40.5
DRY GAS, WT. %	5.0	5.8
TOTAL C_4, VOL. %	12	13.5
COKE, WT. %	4.8	3.9
OCT. NO. F-1 CLR.	90	92.5

OTHER
REASONS FOR USING
FILTROL CATALYSTS

1. Higher Octane Barrels
2. High Butylene Yield
3. Low Cost
4. Varied Plant Facilities
5. Faster Regeneration Rate
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8. Uniformity
9. Lowered Excess Butane

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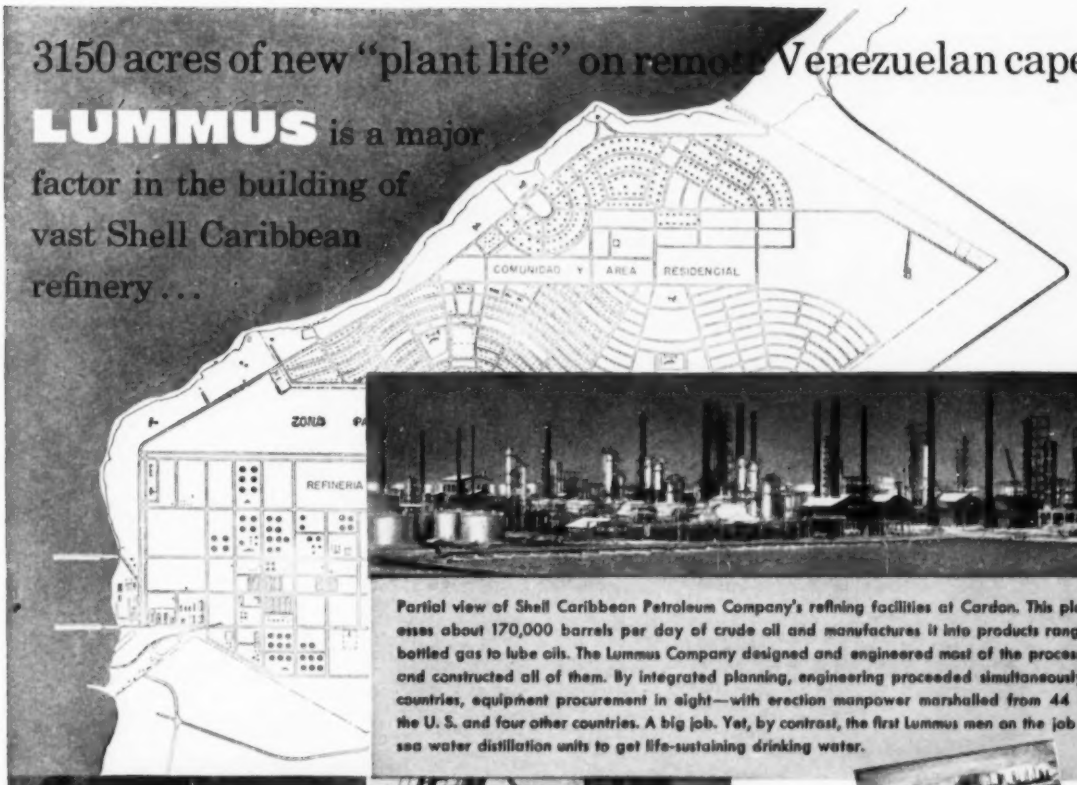
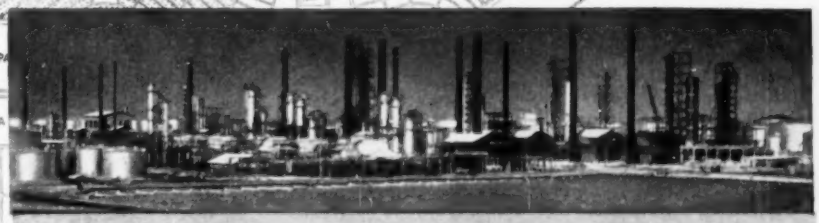
CATALYSTS AND ADSORBENTS

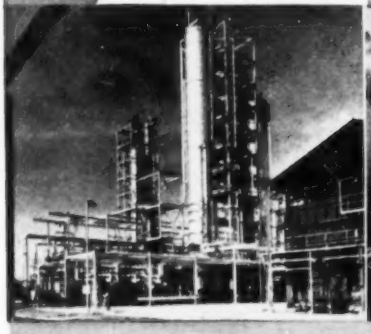
3150 acres of new "plant life" on remote Venezuelan cape...

LUMMUS is a major factor in the building of vast Shell Caribbean refinery...





Partial view of Shell Caribbean Petroleum Company's refining facilities at Cardon. This plant processes about 170,000 barrels per day of crude oil and manufactures it into products ranging from bottled gas to lube oils. The Lummus Company designed and engineered most of the processing units and constructed all of them. By integrated planning, engineering proceeded simultaneously in four countries, equipment procurement in eight—with erection manpower marshalled from 44 states in the U. S. and four other countries. A big job. Yet, by contrast, the first Lummus men on the job installed sea water distillation units to get life-sustaining drinking water.



Cardon's Two Stage Atmospheric and Vacuum Distillation Unit No. 1 (shown here), and its two companion "stills", represent high development of the distillation art. Designed and built by Lummus, these basic plants are characterized by wide flexibility and closely controlled quality of fractionated products. Cardon is also the home of Venezuela's first lubricating oil plant—another in a long list of "firsts" for Lummus in the lube oil field.

Here is good international construction policy (and project economy) in operation. These Venezuelans, rigging a six-sheave block to hoist a 100-ton tower, became adept at erection skills under Lummus' field training system. During the construction period at the Cardon site, key Lummus men also taught welding, pipefitting, maintenance and repair to many local workers; operated a rock quarry, batch concrete and concrete block plants.

Just Off Press... our newest picture brochure, "New Horizons—Lummus at Cardon." Twenty-four pages covering this world-famous plant. May we send you a free copy? Just drop us a line at Room 359, 385 Madison Avenue, New York 17.

Shell-Cardon is a good example of why the Lummus name is well known in the petroleum, petrochemical and chemical fields—and respected for the ability to get big, tough jobs completed rapidly and economically.

THE LUMMUS COMPANY

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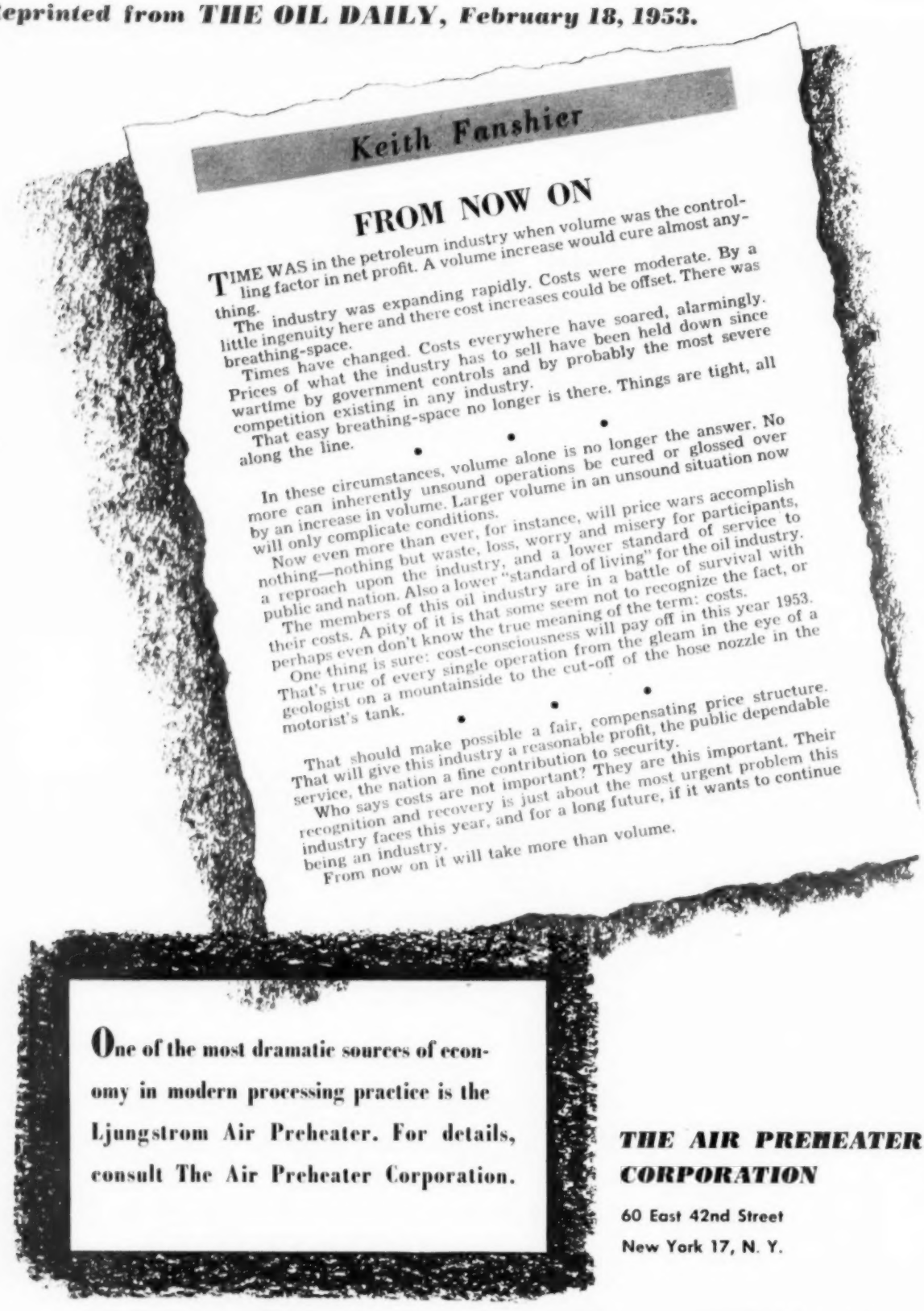
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

Reprinted from ***THE OIL DAILY,*** *February 18, 1953.*



Keith Fanshier

FROM NOW ON

TIME WAS in the petroleum industry when volume was the controlling factor in net profit. A volume increase would cure almost anything.

The industry was expanding rapidly. Costs were moderate. By a little ingenuity here and there cost increases could be offset. There was breathing-space.

Times have changed. Costs everywhere have soared, alarmingly. Prices of what the industry has to sell have been held down since wartime by government controls and by probably the most severe competition existing in any industry.

That easy breathing-space no longer is there. Things are tight, all along the line.

• • •

In these circumstances, volume alone is no longer the answer. No more can inherently unsound operations be cured or glossed over by an increase in volume. Larger volume in an unsound situation now will only complicate conditions.

Now even more than ever, for instance, will price wars accomplish nothing—nothing but waste, loss, worry and misery for participants, a reproach upon the industry, and a lower standard of service to public and nation. Also a lower "standard of living" for the oil industry.

The members of this oil industry are in a battle of survival with their costs. A pity of it is that some seem not to recognize the fact, or perhaps even don't know the true meaning of the term: costs.

One thing is sure: cost-consciousness will pay off in this year 1953. That's true of every single operation from the gleam in the eye of a geologist on a mountainside to the cut-off of the hose nozzle in the motorist's tank.

• • •

That should make possible a fair, compensating price structure. That will give this industry a reasonable profit, the public dependable service, the nation a fine contribution to security.

Who says costs are not important? They are this important. Their recognition and recovery is just about the most urgent problem this industry faces this year, and for a long future, if it wants to continue being an industry.

From now on it will take more than volume.

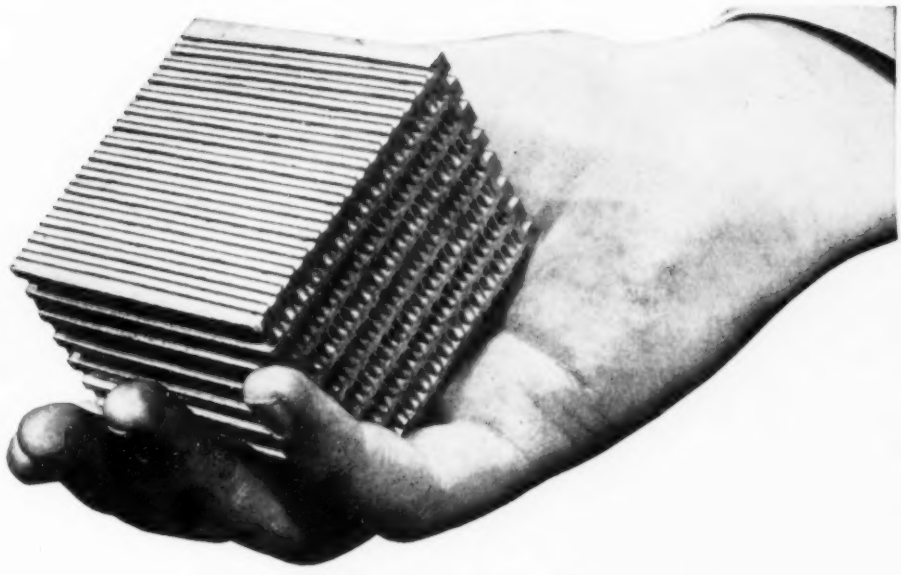
One of the most dramatic sources of economy in modern processing practice is the Ljungstrom Air Preheater. For details, consult The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street

New York 17, N. Y.

Wherever you burn fuel, you need Ljungstrom



This sample section of a TRANE Brazed Aluminum Heat Exchanger shows how its construction can pack up to 450 sq. ft. of surface into a single cu. ft. of space.

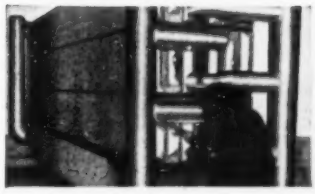
Is this your key to a new product or process?

New TRANE Brazed Aluminum Surface makes NEW products and processes not only possible...but practical. Here's why:

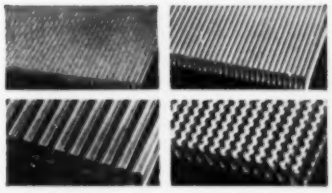
1. Wider range of core sizes and shapes.
2. Greater variety of surfaces.
3. Almost unlimited design flexibility.
4. Up to 9 times more surface for the heat exchange job than with conventional ¾" shell-and-tube construction.
5. Light weight. Yet takes test pressures up to 1,000 lbs. per sq. inch and temperatures from −300° to 500° F.
6. Can handle 5 fluids or more at one time.
7. Can produce more heat transfer in ¼ the space, with ⅕ the weight.

What's your heat transfer problem? Liquid-to-liquid, gas-to-gas, liquid-to-gas? Condensing and vaporizing fluids? You may find a new and better solution in this new kind of all-aluminum heat transfer surface . . . developed by TRANE.

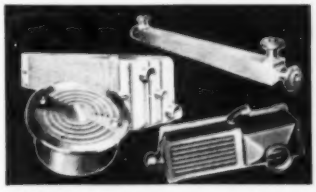
Write on your company letterhead for your FREE copy of "Extended Surface Heat Transfer Equipment."



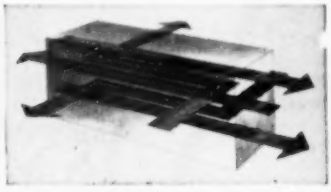
On large or small jobs, TRANE Brazed Aluminum Heat Exchangers can solve almost any heat transfer problem. Multiple-core units can be furnished. You can get temperature approaches of 5° to 10° F.



Select the surface you need. Straight and continuous, serrated, herringbone or perforated. Height, thickness and fin-spacing also can be varied to meet required heat transfer and pressure drop performance.



Design flexibility makes possible heat exchangers in many shapes . . . and in sizes up to 106" in length, with either bolt-on or integrally welded headers. For longer flow lengths, cores can be welded together in series.



Handle up to 5 fluids or gases, even more, at once. This symbolic drawing shows how. If your job requires one stream or many—high or low temperatures or pressures—solve it with TRANE Brazed Aluminum Heat Exchangers.

More heat exchange . . . closer temperature approaches

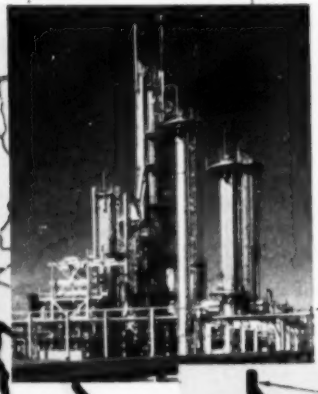
TRANE brazed aluminum heat transfer surface

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U.S. and 14 Canadian Offices

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

HISTORY AT WORK.

Fluid Cat Cracker of the Kanotex Refining Company of Arkansas City, Kansas. Designed for 4600 barrels per stream day with a coke burning capacity of 5100 pounds per hour. The vacuum unit charges Kansas reduced crude at the rate of 5750 barrels per stream day.



Fluid Cat Cracker for El Dorado Refining Company of El Dorado, Kansas. Designed for 4300 barrels per stream day with a coke burning capacity of 5100 pounds per hour. Construction also included gas concentration unit and revamp of 1224 barrel day U.O.P. nonselective Polymerization unit.

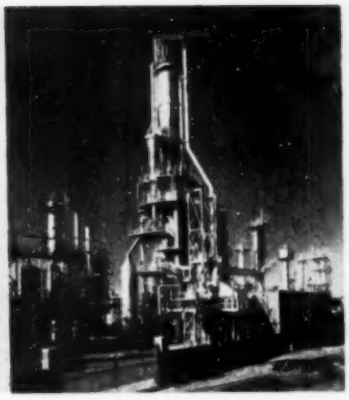
CONSTRUCTION PROJECTS

At the right is the legend to the various types of construction jobs by TRECO in the various states.

LEGEND

- Catalytic Cracking Unit
- Complete Plant Erection or Dismantling
- Gasoline Plant
- Compressor Station
- Pumping Station
- Pereo Unit
- Thermal Cracking Unit
- Crude Unit
- Vacuum Unit
- Terminal
- Poly Plant
- Combo Unit
- Asphalt Plant
- Alkylation Unit
- Dehydration Plant
- Micro-Wave Booster Station
- Pumping Booster Station
- Oil Shale Plant
- Petrochemical Facilities

. . . IN REFINING . . . . .



Fluid Cat Cracker for Farmers Union Central Exchange, Laurel, Montana, of 5,000 barrels per day at 70% conversion. 2 stage gas concentration units; solid phosphoric acid Polymerization unit. Tank car and truck loading facilities for LPG.

Last year was the greatest construction year in the refining industry. This year promises to be even greater. Thinking operators know they can't win in quantity or quality production with out-moded plants. That's why TRECO receives contracts for a number of new plants each year, putting the owner in a more competitive position.

REFINERY ENGINEERING Company has proven to the industry that it builds a quality refinery, producing top-quality products; "on stream" with new records for speed of construction. From an economic study of your needs to operating costs, yields and profits; through design and construction, TRECO has the knowledge, experience and manpower to complete the most complicated construction and installation in the shortest possible time.

Call on TRECO for a conference while your project is still in the planning stage. Executives of our organization are as near as your telephone.

TRECO has been licensed to design, engineer and construct Catalytic Reforming Units.

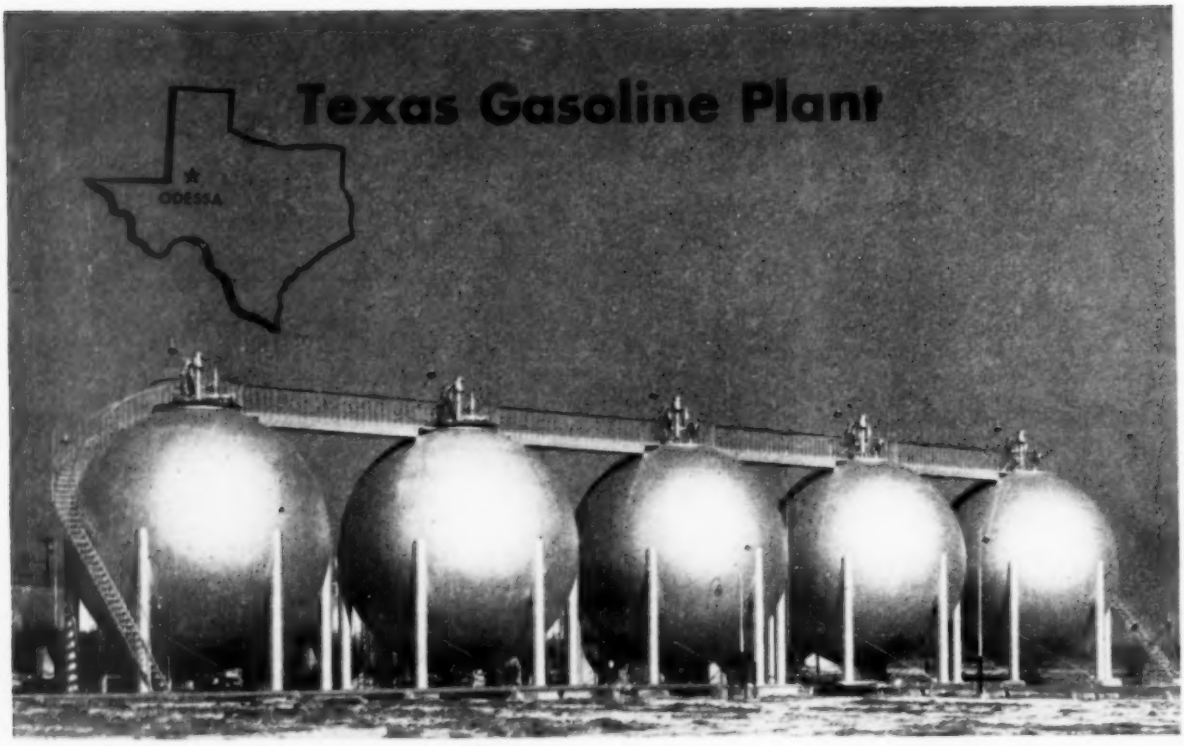
Write for a free copy of our new brochure showing many of the refineries we have constructed. A copy will be mailed you promptly upon request on your company letterhead.

TRECO

REFINERY ENGINEERING *Company*

HOUSTON, TEXAS **TULSA, OKLAHOMA** **TORONTO, CANADA**

(To obtain more data on advertised products see page 768)



stores Natural Gasoline and Butane in HORTONSPHERES*

Light hydrocarbons such as butane cannot be stored at atmospheric pressure and temperature. Gulf Oil Company's Waddell gasoline plant stores butane in three of the five 2,500-bbl. Hortonspheres shown above which are designed to operate at 100 lbs. per sq. in. pressure. Natural gasoline is stored in the other two Hortonspheres which are designed for an operating pressure of 30 lbs. per sq. in.

Hortonspheres are built in standard capacities from 1,000 to 30,000 bbls. Information on these efficient storage units or other Horton structures may be obtained by writing our nearest office.

Visit our exhibit at the INTERNATIONAL PETROLEUM EXPOSITION May 14th to 23rd, 1953 Booths No. 85-86-125-126 in the Texas Building

*Welding supervisor checks construction of every HORTONSPHERE

A Chicago Bridge & Iron Company Field Welding Supervisor is assigned to follow the construction of every tank we build. This service, which assures you that the tank is built in accordance with the specifications, is yours at no extra cost.

CHICAGO BRIDGE & IRON COMPANY

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Chicago 4 ..... 2114 McCormick Building
Cleveland 15 ..... 2215 Midland Building
Detroit 26 ..... 1532 Lafayette Building
Havana ..... 402 Abreu Building
Houston 2 ..... 2130 C&I Life Building
Los Angeles 17 ..... 1526 General Petroleum Building
New York 6 ..... 3310—165 Broadway Building
Philadelphia 3 ..... 1630—1700 Walnut St. Building
San Francisco 4 ..... 1559—200 Bush Street
Seattle 1 ..... 1330 Henry Building
Tulsa 3 ..... 1620 Hunt Building

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Uniform, High Quality

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VISCOSITY INDEX IMPROVERS

A pioneer and leading marketer of viscosity index improvers, the Enjay Company is meeting the Petroleum Industry's constantly increasing demand for PARATONE. Refiners and marketers of High V. I. motor oils with product specifications that call for both maximum on-the-road performance and economical treating cost use ENJAY PARATONE for improving viscosity index.

ENJAY

A complete line of dependable products for Industry

PETROLEUM	SURFACE COATING	CHEMICAL
PARANOX	PETROHOL 91	PETROHOL 91
PARATONE	PETROHOL 95	PETROHOL 95
PARAFLOW	PETROHOL 99	PETROHOL 99
PARAPOID	Secondary Butyl Alcohol	Iso-Octyl Alcohol
PARADYNE	Secondary Butyl Acetate	Decyl Alcohol
PARATAC	Isopropyl Acetate	Trideeyl Alcohol
PETROHOL	Acetone	Dicyclopentadiene
Methyl Ethyl Ketone	Methyl Ethyl Ketone	Isoprene
Dewaxing Aid	Ethyl Ether	Butadiene
Ethyl Ether	Isopropyl Ether	Ethyl Ether
Isopropyl Ether	Dicyclopentadiene	Isopropyl Ether
Reference Fuels	Naphthenic Acids	Tripropylene
	Iso-Octyl Alcohol	Tetrapropylene
	Decyl Alcohol	Aromatic Tars
		Acetone
		Methyl Ethyl Ketone

The Enjay Company has long been recognized as a leader in the development and marketing of high-quality products for the oil, surface coating and chemical industries. Backed by greatly expanded plant and distribution facilities, the Enjay Company is supplying a constantly growing list of chemical products to many different industries.

Be sure to call on Enjay for your chemical needs

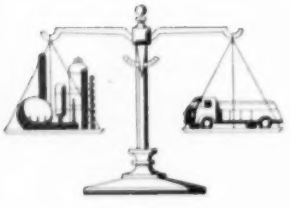
ENJAY COMPANY, INC.
15 West 51st Street, New York 19, N.Y.

Announcing!

NEW Dispersant FO

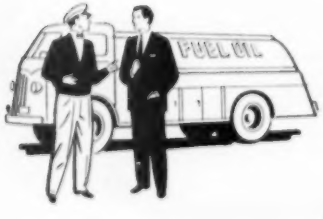
(DOMESTIC BURNER OIL INHIBITOR)

Market a better Furnace Oil while using more cat-cracked fuel stocks, improving refinery balance



Dispersant FO improves stability and permits blending of higher percentages of cat-cracked stocks. Refinery balance can be improved, and you can even cut costs by reducing the severity of acid treating your heating oil stocks. Economical Dispersant FO may be easily added in the ratio of 1 pint/1000 gallons, *at any temperature*, prior to shipment by truck, tanker or pipe line. This unusual inhibitor does not materially increase suspension of water, and excessive settling time is not encountered.

Provide your dealers Furnace Oil with NEW competitive advantages



Dispersant FO is an anti-gumming, rust-inhibiting additive that greatly reduces or even eliminates deposits in home heating units and storage tanks. It gives dealers competitive advantages because they can supply a better product to home owners and cut down on costly service calls to clear clogged filter screens and nozzles. Dispersant FO will not affect burning or heating properties of the oil.

For further information and product sample, write or phone the nearest Oronite office. Technical assistance gladly provided.

ORONITE CHEMICAL COMPANY

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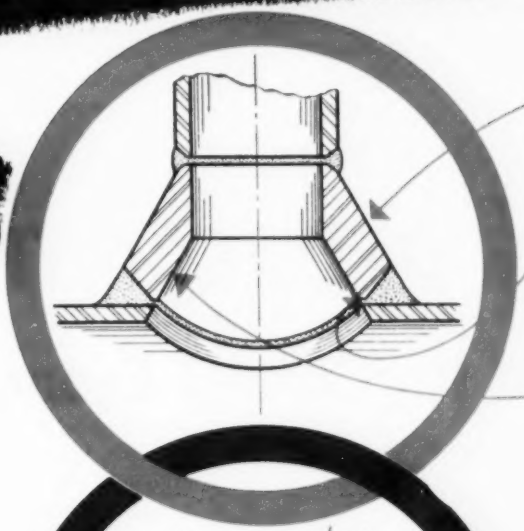
600 S. MICHIGAN AVENUE, CHICAGO 5, ILLINOIS
MERCANTILE SECURITIES BUILDING, DALLAS 1, TEXAS

ORONITE CHEMICAL COMPANY
THE NAME TO WATCH IN CHEMICALS

2758

(*To obtain more data on advertised products see page* 768)

Engineered Reinforcement Against CORROSIVE ATTACK at Branch Connections



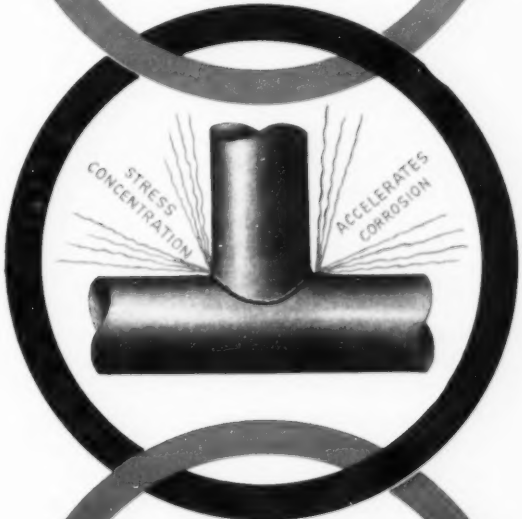
Designed with thick, tapered section to relieve stress concentration.

Additional metal prevents branch connection from corroding dangerously thin.

Funneled inlet relieves stress concentration at point of highest magnitude—the *inside* of the crotch.

Accelerated corrosion due to stress concentrations can be readily eliminated . . . by using WELDOLET WELDING FITTINGS at all 90° branch connections.

When corrosion exists in a piping system, it attacks the points of stress concentration most severely. WHY DOWN-RATE YOUR PIPING SYSTEM BECAUSE OF THIS WEAK LINK?



SPECIFY AND USE . . . . . BONNEY WELDOLET WELDING FITTINGS to insure 100% pipe strength at branch connections under corrosive conditions.

WeldOlets, butt-welding

ThredOlets

WeldOlets, socket-welding

FOR COMPLETE ENGINEERING DATA WRITE FOR YOUR BONNEY W-3 CATALOG

DISTRIBUTORS IN PRINCIPAL CITIES

WELDING FITTINGS DIVISION

BONNEY FORGE & TOOL WORKS

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ALLENTOWN, PENNSYLVANIA

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

DEPRECIATION

And Its Crucial Economic Role

The sixth annual McGraw-Hill survey of Business' Plans for New Plants and Equipment, just completed, reveals some remarkable facts about the role of depreciation in our economy. To most people, depreciation is a technical term, used by accountants to discuss a dull subject. But it really is a simple matter: It is the amount of money set aside each year by a company to replace plant and equipment that is wearing out. And here are some facts from this survey* which show how depreciation can make the difference between prosperity and recession in the United States:

1. *In 1953, about half of all the money spent on new manufacturing plants and equipment will come from depreciation reserves.* For the future, manufacturing companies are relying even more heavily on this source of money. In the years 1954-56, they count on using their depreciation funds to pay for almost two-thirds of the new plants and equipment now planned.

2. *The amounts of money made available by depreciation allowances vary greatly from industry to industry.* Some industries, such as those producing steel, chemicals and petroleum products, will have relatively large amounts of cash available from their depreciation reserves. In considerable measure, this is because the government is allowing them to accumulate such reserves at an accelerated rate as an encouragement to build facilities required for national defense. But most of the companies engaged in the production of textiles, processed foods and many kinds of machinery have had little chance to benefit by this provision for accelerated depreciation. Hence, they have much less money available from depreciation reserves.

3. *There is a definite shortage of investment funds in the industries that have relatively low depreciation allowances.* Taken together, the coal mining, textile, food processing, machinery and other metal-fabricating industries plan to spend about $4.7 billion for new plant and equipment this year. But they report that they would spend $1.5 billion *more* per year during the period 1954-56 if sufficient funds were available.

4. *Eighty-five per cent of the manufacturing companies covered by the survey reported that they plan to invest all their depreciation funds* to keep equipment up-to-date and to provide capacity for new products and new markets. These companies could let their depreciation funds pile up as idle cash. But the intention is to spend most of them for capital equipment.

*The sixth annual McGraw-Hill survey of Business' Plans for New Plants and Equipment included companies that provide 25 per cent of all industrial employment and 60 per cent of employment in those industries where capital investment is highest. These companies are mostly the larger companies in their respective industries. A copy of the full report of this survey can be obtained by addressing: Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y.

(*To obtain more data on advertised products see page* 768)

Hence, there is a direct relationship between the amount of depreciation funds available and the level of capital investment. And it is upon the latter that the level of general prosperity decisively depends. One-third of all industrial workers are engaged in producing or installing such equipment.

This fact that the level of depreciation allowances has a major bearing on the level of capital investment should not surprise anyone. In several foreign countries where these allowances have been increased, investment has boomed. The two nations with the highest ratios of investment to national income are Canada and Norway. Both countries adopted flexible depreciation policies after World War II. In Sweden and The Netherlands also, flexible depreciation allowances have contributed to rapid industrial expansion. Finally, the tremendous investment brought about by our own rapid amortization program shows dramatically the importance of depreciation in stimulating capital expenditures.

Obsolete Tax Laws

In spite of this record, the fact remains that our laws and the business procedures that govern depreciation allowances — in particular the laws and rulings that govern the deduction of depreciation from taxable corporate income — are still based on antique and obsolete accounting concepts which take no account of depreciation's dynamic role in our economy. The internal revenue code still requires most companies to depreciate their equipment over a long period, even though these small annual allowances cannot possibly pay for the investment that is necessary to keep a plant up-to-date under today's rapidly changing technology, with its production of new and improved machinery.

The only allowance made by the government for rapid depreciation is that which is authorized for certain types of plants during the defense emergency. Under this policy most companies are unable to use accelerated depreciation for tax purposes. And as defense projects are completed, the number of new authorizations is dropping. We may lose the chance to utilize fully this powerful tool for sustaining investment because, under our ramshackle emergency tax structure, accelerated depreciation is available only to a minority of firms on a temporary basis.

New Policy Needed

A sensible, up-to-date depreciation policy for tax purposes is long overdue. Either the Treasury must modernize the internal revenue code on its own initiative, or Congress must take the lead by writing into permanent law a flexible depreciation policy applicable to all companies.

Treasury experts now have before them a number of proposals to allow faster depreciation for the average firm. The U.S. Chamber of Commerce has suggested that companies be allowed to deduct from taxable income 25 per cent of the cost of new equipment in the first year, with the remaining cost to be deductible over the life of the facilities. The Machinery and Allied Products Institute has long sponsored a formula that would allow full deduction in two-thirds of the estimated life of the property. In Congress, Chairman Reed of the Joint Committee on Internal Revenue Taxation has stated that we need a more flexible depreciation policy. Senator Frear of Delaware has introduced a bill that would let a business make its own choice on how fast to depreciate its equipment.

It will take time and study to determine which of these various proposals best fits the needs of the economy without sacrificing unduly the revenue needs of the government. If we are to have a new depreciation policy, designed for a long period ahead, it must be carefully worked out. But this much is clear right now: *The development of a flexible depreciation policy on the part of the federal tax authorities is one of the most important steps that can be taken to sustain prosperity. When we talk about depreciation, we are talking about the money that pays for almost two-thirds of the new manufacturing facilities now scheduled for construction. We are talking about the new investment and the new jobs on which our continued prosperity depends.*

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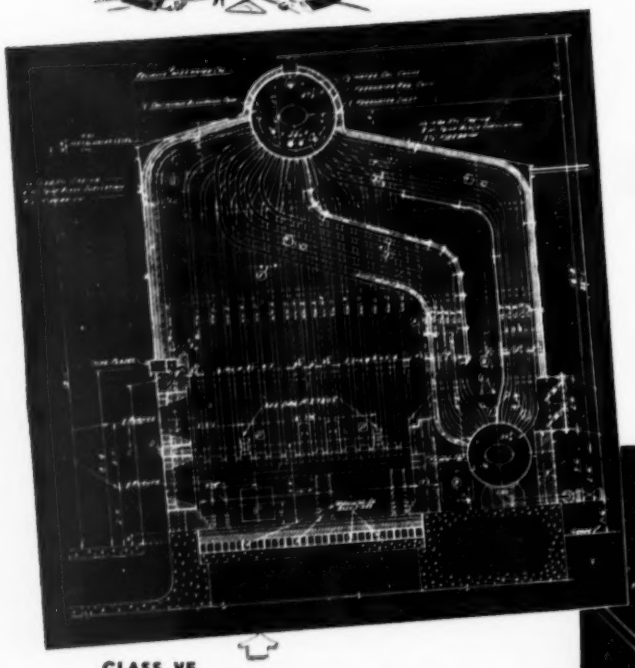
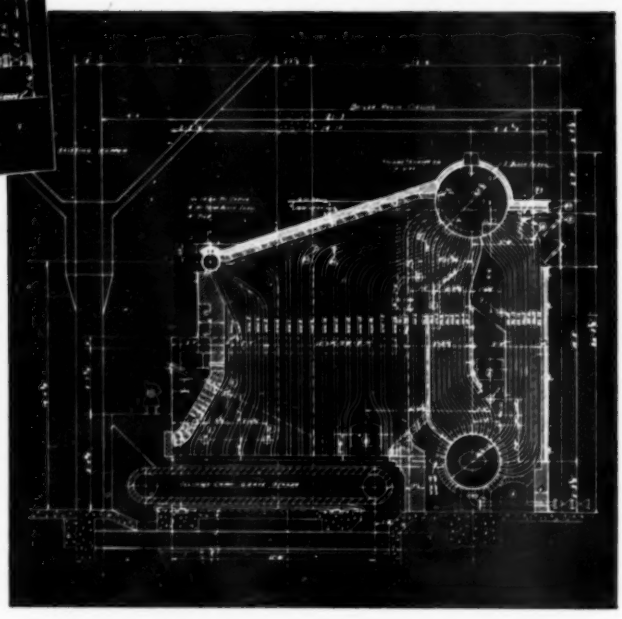
Industry Approved

Two-Drum STEAM GENERATORS by Vogt



CLASS VF
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



CLASS VS
The Seelbach Hotel, Louisville, Ky. is served by this 50,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

A bulletin with general information and showing typical installations is available on request.

Typical Users...

FOOD PROCESSING PLANTS

DISTILLERIES • HOTELS

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PETROLEUM REFINERIES

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BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

LATEST MODEL

Alkylation Unit for SOHIO

THIS model of an alkylation unit was built from engineering drawings to a scale of ¼ inch to 1 foot. Its purpose is to help check engineering and speed up construction of a new alkylation unit designed and now being constructed by Arthur G. McKee & Company for Standard Oil Company of Ohio at Toledo.

The Sohio project is one of four new alkylation units now in progress by the McKee organization. The others are located at Wood River, Illinois; Norco, Louisiana and Texas City, Texas. Combined capacity of the four units will be approximately 21,000 barrels of alkylate production per stream day.

ENGINEERING, PURCHASING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

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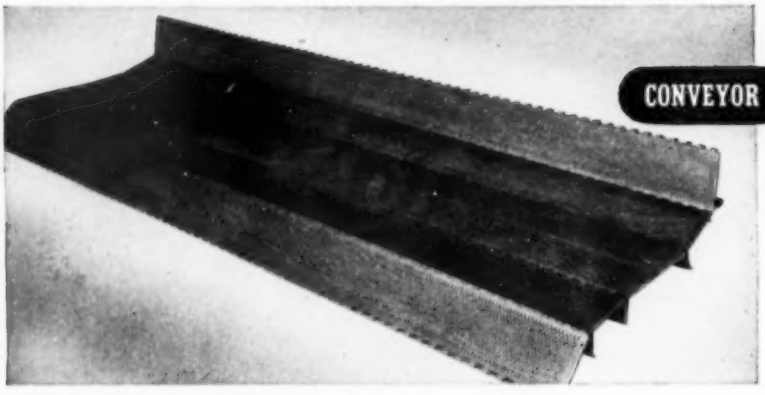
SPECIALISTS IN

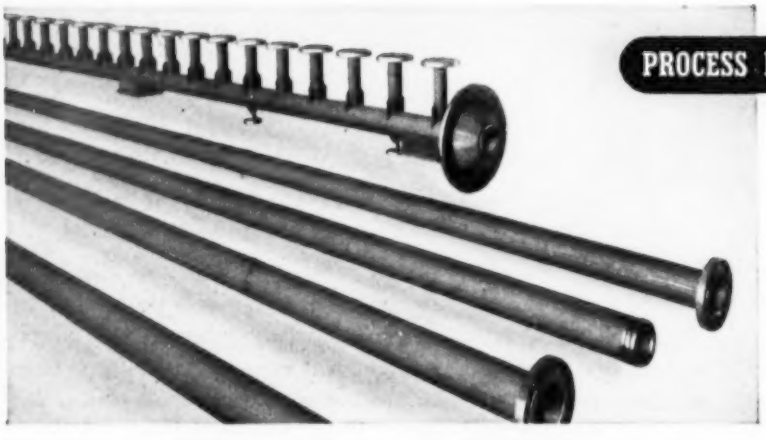
ALLOY BUBBLE CAPS FOR OIL REFINING

You will find, we believe, the largest compilation of engineering data on bubble caps and risers in PSC Catalog 52. All standard styles; furnished without die cost and in any alloy. Special caps to your order.



CONVEYOR FLIGHTS FOR SYNTHETIC RUBBER

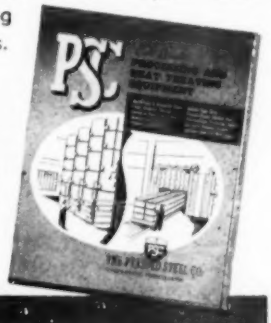
Used on dryer conveyors in most plants. In any alloy, and specifications as to size and perforations. A typical example of PSC's precision sheet alloy fabrication for the process industries.



Piping in any diameter up to 60"; any section to ⅜"; of any alloy, permitting use of the particular metal best suited to a specific heat (to 2200°F)

PROCESS PIPING FOR PETRO-CHEMICALS

or corrosion condition. Large precision fabricators of complex welded tubing assemblies.



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Process Equipm't CATAL'G 52

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY — MAY 1953

NOTES ON

Ammonia

Of vital importance to the efficiency and low maintenance cost of any ammonia plant is the design of the reactor in which synthesis gas is converted to the end product.

* * *

Close control of temperature is extremely important in the reactor. To attain a reaction rate high enough to produce an economic yield of ammonia, temperatures must closely approach a critical point. Should this point be exceeded, catalyst activity deteriorates rapidly and construction materials are subject to accelerated attack by corrosion.

* * *

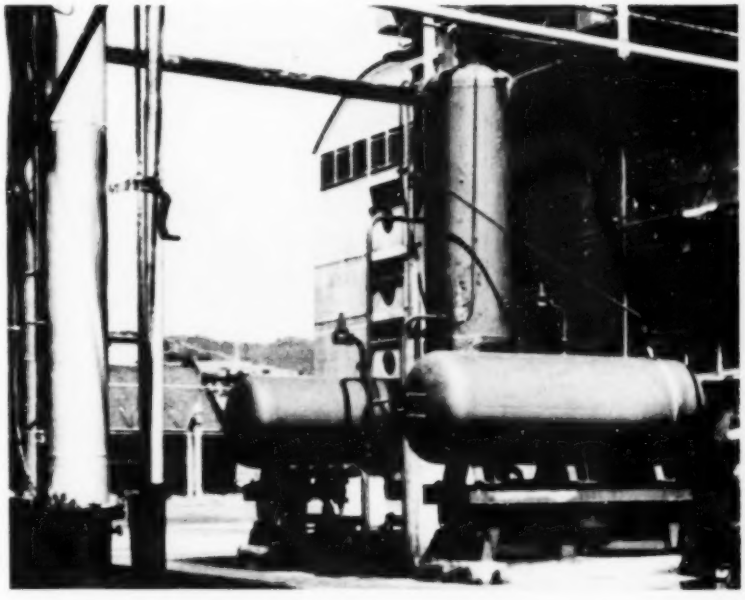
In the ideal ammonia converter, it is essential to remove excess heat as rapidly as possible from every point where exothermic reaction occurs. Since these points "move about" through changes in the conditions of operation and through aging of catalyst, the design of an economical converter that completely solves the problem of excess heat removal is a difficult engineering feat.

* * *

The Kellogg reactor, which employs layers of catalyst with an efficient means of cooling the gases in between, closely approaches the ideal point-by-point temperature control.

* * *

In addition to a 150 ton-per-day plant now going up on the West Coast, Kellogg has designed several others employing this type of reactor. Three large ones were built virtually simultaneously during World War II. Since they have been in operation they have continued to maintain the highest efficiency levels in the industry.



Lower Initial Investment, Decreased Operating Cost with New Urea Process

A new, low-cost method of producing synthetic urea of exceptional purity from ammonia and carbon dioxide is now available in the United States through Kellogg. Known as the Montecatini Urea Process—after the well-known Italian firm which developed it—the method reflects more than 30 years of experience in nitrogen chemistry.

One of the important features of the Montecatini process is the reduction in operating cost due to the virtual elimination of the corrosion problems generally associated with urea synthesis. This is accomplished not only through judicious materials selection but also through the use of relatively mild operating conditions in the reaction zone in comparison with other urea processes. Furthermore, high concentration of ammonia also tends to curb corrosion.

To reduce initial investment, as well as operating costs, the process employs a partial recycle of ammonia and ammonium carbamate in liquid form in order to keep to a minimum the need for costly compressors. The lower temperatures employed eliminate the necessity for employing expensive alloy equipment in many parts of the plant.

While a total recycle plant that gives 100% yields has been piloted, the present commercially operating process makes it possible to obtain 70 and 80 wt. % conversion of NH_3 and CO_2 respectively. Considering the fact that urea production is often in connection with the preparation of fertilizer products, the existence of excess ammonia in the tail gas provides a ready source of NH_3 for additional production of the standard sulfate and nitrate fertilizers.

In addition to these factors affecting the costs of plant and operation, it is also of interest that the process produces resin-grade urea under all conditions without the additional expense of a special purification step to remove entrained impurities. The product from the Montecatini process meets the following specifications:

Nitrogen	46.3 wt. %
Water Content	0.5 wt. %
Free NH_3	0.02 wt. %
Ash	0.003 wt. %
Biuret	0.01 wt. %
Aqueous solution of 5% urea	clear and colorless

This final specification is a difficult one to meet and is particularly important for plastics manufacture. The low biuret content is also of importance in this application.

This process employs no lead-lined equipment, eliminating any possibility of lead toxicity when urea is used as cattle feed supplement.

(SEE REVERSE SIDE)

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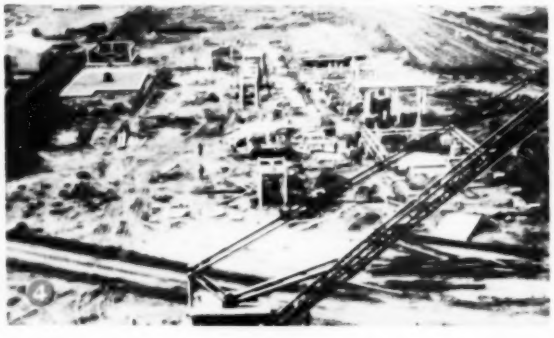


More than 20 Major Chemical Processing Steps Involved in Project

The South African project to obtain gasoline, diesel fuel and chemicals from indigenous coal deposits is now well underway. The huge $850 million plant, for which Kellogg is project manager, comprises a multitude of different units. The overall program includes projects from the opening of a virgin coal mine to the final production of fuels and purification of chemicals. Progress photos shown here include just four of the major chemical processing projects included in this most complex chemical engineering-contracting task for South African Coal, Oil and Gas Corporation (SASOL).

Photo No. 1 shows the unit which will receive the gas stream from the coal gasification plant to produce synthesis gas. This is then fed to Kellogg's unique Synthol process (Photo No. 2) where the actual synthesizing step is performed. Progress on the fixed bed catalytic operation is shown in Photo No. 3. When completed, the foundations shown in Photo No. 4 will support the oil recovery system.

Among the chemicals which will be produced as dictated by market conditions are ethanol, propanol, butanol, acetone, methyl ethyl ketone, benzol, toluol, phenol, ammonium sulfate, light and heavy creosotes and several waxes and tars.

* * *

For further information, technical data, etc., relating to chemical or petrochemical processing, write

CHEMICAL PROCESS DIVISION

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

Also Jersey City, Los Angeles, Tulsa, Houston, Toronto, London and Paris

M KELLOGG — PULLMAN

RESA Branch Is Installed at Kellogg

Dr. Donald B. Prentice, National Director of the Scientific Research Society of America (RESA), presents official charter to Joseph F. Skelly, first president of the new Kellogg RESA branch. Warren L. Smith, president of Kellogg standing at left, was one of prime movers for formation of a RESA unit. The Company mustered 58 charter members at the recent investment ceremony, expects the branch's eventual membership to number in the hundreds.

Armeen® C stops corrosion in pipe lines, condensers – increases throughput!

Field tests prove efficiency of new Armour chemical

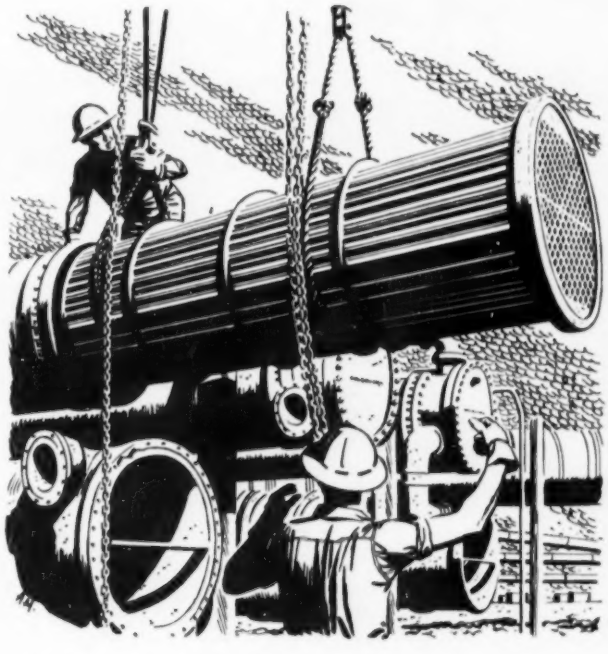
Armeen® C is one of Armour's new corrosion inhibitors —one that is setting records for efficiency and economy wherever it is used.

In recent tests on the west coast, inhibitors were tried in a casinghead gasoline condenser where corrosion from small amounts of water, traces of hydrogen sulfide and 1-2 ppm carbon dioxide was a real problem. Damage was constant and considerable, and at frequent intervals the equipment had to be shut down while the condenser tubes were pulled for cleaning. The tubes would actually accumulate so much residue that it could be cleaned off with a shovel. Due to the high rate of corrosion the condensers were replaced approximately every 18 months.

After they started injecting Armeen C the tubes were removed in the absence of the engineer in charge. When he first saw the tube bank—without *any* corrosion—he thought the tubes had already been steam-cleaned, and rebuked the foreman for ruining the test. But Armeen C —not cleaning—was responsible for the absence of corrosion.

Armeen C is now used extensively in this plant. Since its introduction, the throughput of the system has increased 20%. Coupon tests show that weight loss of one coupon dropped from 30 grams a month to less than 1 gram in two months—they no longer bother to test for weight loss! Corrosion engineers now estimate that the condensers will last for 10 years!

Gas lines, crude pipe lines, sour crude producing wells, product lines, flood systems — in all of these



Armeen C and other Armour corrosion inhibitors have proved versatile, economical, and highly efficient.

Send the coupon with your letterhead for a free sample of Armeen C and a new technical bulletin, "Combat Corrosion", which covers our complete line of inhibitors.

Armeen® C is a registered trade name of Armour and Company

Mail This Coupon Today!

Armour and Company
1355 West 31st Street, Chicago 9, Illinois

Please send me the following:

- ☐ Sample of Armeen C
- ☐ "Combat Corrosion" Technical Bulletin

Name

Title

Firm

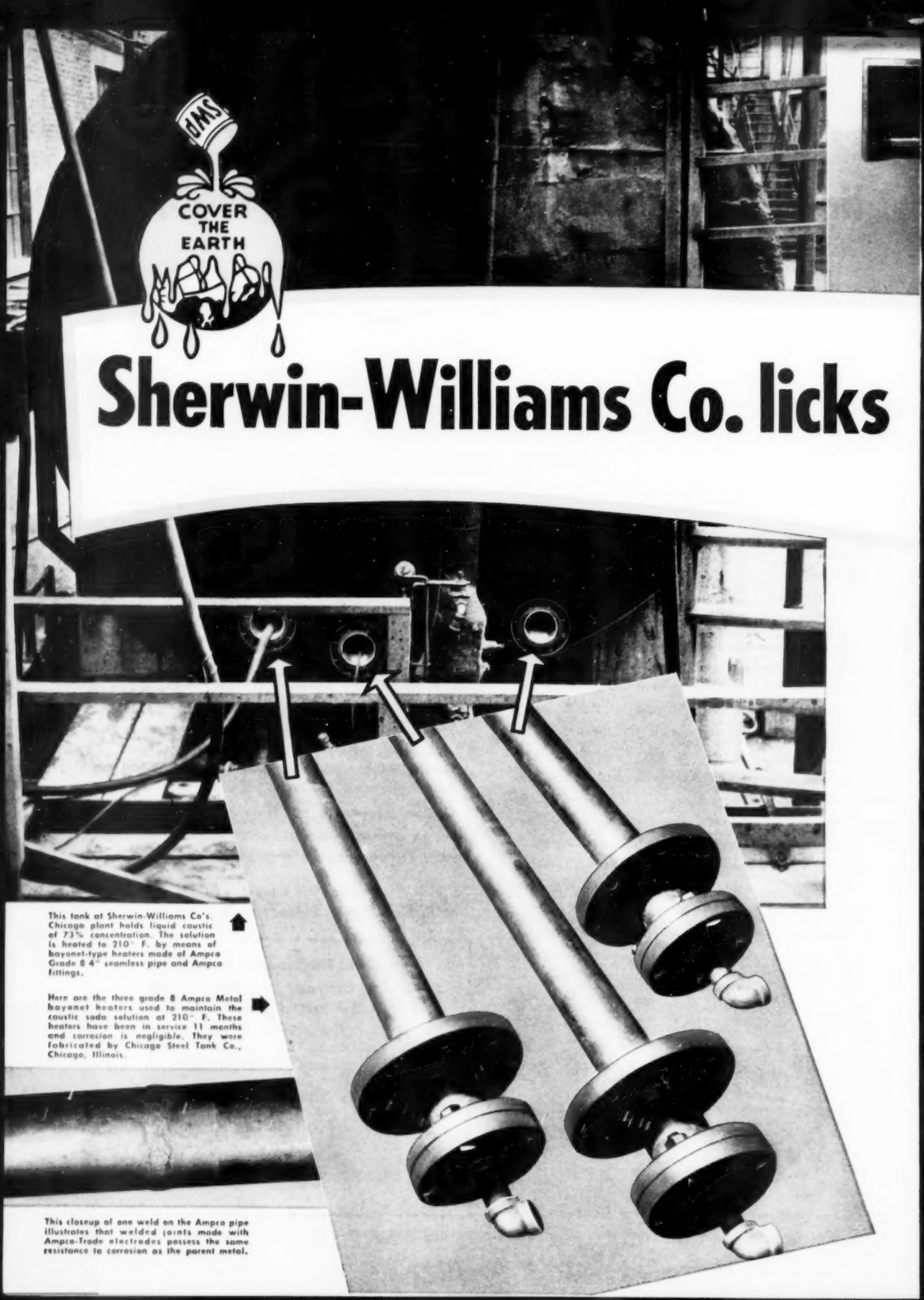
Address

City *Zone* *State*

P

ARMOUR CHEMICAL DIVISION

© Armour and Company, 1355 West 31st Street • Chicago 9, Illinois

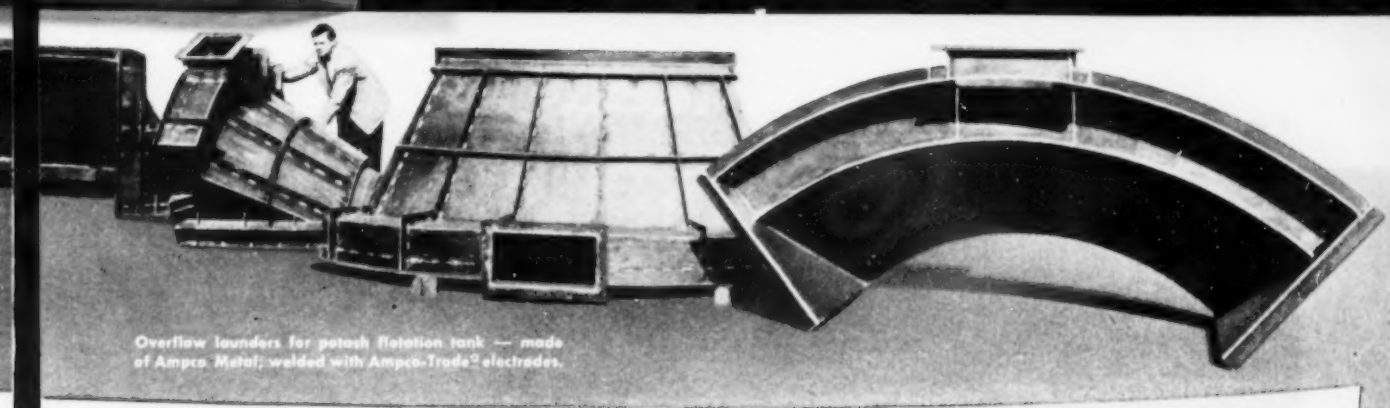


Sherwin-Williams Co. licks

This tank at Sherwin-Williams Co's. Chicago plant holds liquid caustic of 73% concentration. The solution is heated to 210° F. by means of bayonet-type heaters made of Ampco Grade 8 4" seamless pipe and Ampco fittings.

Here are the three grade 8 Ampco Metal bayonet heaters used to maintain the caustic soda solution at 210° F. These heaters have been in service 11 months and corrosion is negligible. They were fabricated by Chicago Steel Tank Co., Chicago, Illinois.

This closeup of one weld on the Ampco pipe illustrates that welded joints made with Ampco-Trode electrodes possess the same resistance to corrosion as the parent metal.



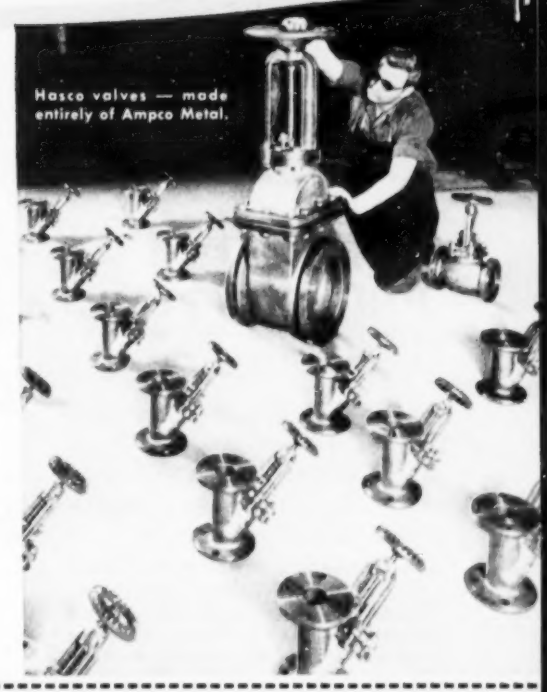
Overflow launders for potash flotation tank — made of Ampco Metal; welded with Ampco-Trode* electrodes.

CAUSTIC CORROSION *with* AMPCO* METAL

Like Sherwin-Williams Co., manufacturer of top-quality paints, an ever-increasing number of companies in the process and petro-chemical industries are using Ampco Metal to solve corrosion and many other problems.

Here's why! Ampco Metal Grade 8, one of a series of engineered aluminum bronze alloys, has these important properties: high resistance to corrosion...high tensile strength (75,000 psi)...high physicals at extreme temperatures . . . high strength-to-weight ratio . . . high impact and fatigue values (Charpy @ −423° F., 93 ft. lbs., @ 70° F. 75 ft. lbs. fatigue limit 28,000 lbs. @ 100,000,000 cycles) . . . high resistance to wear from erosion, abrasion, cavitation-pitting . . . high compressive strength (E. L. in Comp. 25,000 psi) . . . high modulus of elasticity (18,000,000) . . . easy to fabricate with Ampco-Trode* welding wire and coated electrodes.

Ampco Grade 8 has Boiler Code Approval and is available in sheet, plate, extrusions, pipe, tubes and fasteners. It may be the solution to your corrosion problems. Consult your nearest Ampco Field Engineer or write us for further information.



Hasco valves — made entirely of Ampco Metal.

Tear out this coupon and mail today!

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

Ampco Metal, Inc.
MILWAUKEE 46, WISCONSIN
West Coast Plant
BURBANK, CALIFORNIA

AMPCO®

AMPCO METAL, INC., Dept. PP-5, Milwaukee 46, Wis.

Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

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City.....(.....) State.....

PP-10

In Natural Gasoline Plants, too....

JOHNSTON PUMPS ARE DOING A BETTER JOB...

Take these cooling tower pumps at a natural gasoline plant in West Edmond, Oklahoma. There were MANY reasons why Johnstons were selected for this job. Here are just TWO—

NON-OVERLOADING POWER CHARACTERISTIC

The flat horsepower curve of the Johnston vertical turbine pump allows operation against either throttled discharge or reduced heads without danger of overloading the driver. This advantage often saves the difference between the proper size motor and an oversize motor to prevent overloads when operating at other than the basic design condition.

GREATER EFFICIENCY OVER A WIDER RANGE

Johnston Pumps accommodate variations in head by staging, whereas for heads falling between standard sizes of the horizontal centrifugal, this can be accomplished only by trimming the impellers. This trimming is restricted to a small range in head, or else the pump's efficiency is impaired.

This is another typical example of the ability of Johnston equipment to handle all types of pumping jobs in large or small operations. Why not call us about YOUR particular problem. We're always glad to help.

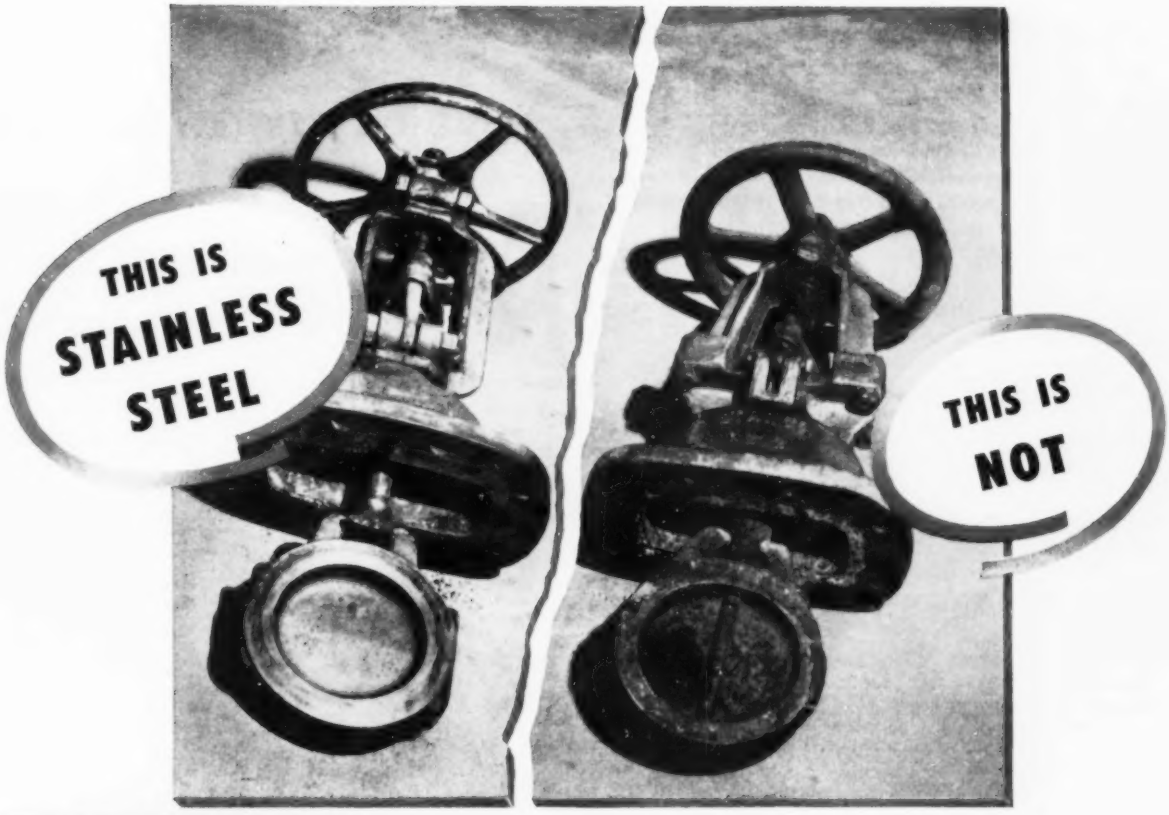
Send today for your free copy of our bulletin "Fluid Force." Ask for Bulletin B-53.

See Our Exhibit
OIL SHOW
TULSA MAY 14-23

JOHNSTON
VERTICAL PUMPS

JOHNSTON PUMP COMPANY

3272 EAST FOOTHILL BLVD., PASADENA 19, CALIFORNIA



ANOTHER GROUP of Stainless Steel valves used in the operation of this Gulf Coast Refinery.

—yet the Stainless valve is twice as old!

HERE'S photographic evidence of the way Stainless Steel's superior corrosion resistance keeps it in service under severe conditions far longer than other materials.

Both of these end gate valves were in service in one of the pipe stills at a Gulf Coast Refinery. The valve at the left, trimmed with Stainless Steel, is still in excellent condition after two years of service in light Crude Naphtha containing sulfur compounds. But the other valve, made of less durable materials, failed after a year of the same kind of service.

Stainless Steel's ability to stand up under severe service pays off in fewer costly shutdowns, less maintenance and longer equipment life. In many applications, it is far and away the most economical material you can use.

For finest performance, make sure the Stainless you use is perfected, service-tested U·S·S Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S STAINLESS STEEL

USS

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

3-875

UNITED STATES STEEL

ECONOMICAL answers to industrial problems—a few of which are shown on these pages—call for specialized *facilities* and years of *experience.*

Here at Alco you will find a large measure of both. You will find experience gained through many years of designing and fabricating heavy metal equipment for petroleum, chemical, power and manufacturing companies all over the world.

You will find modern equipment and machines, many of them designed and built by Alco, capable of meeting almost every conceivable type of metal-fabricating requirement—facilities operated by skilled craftsmen, and applied by designers and engineers fully aware of industry's needs.

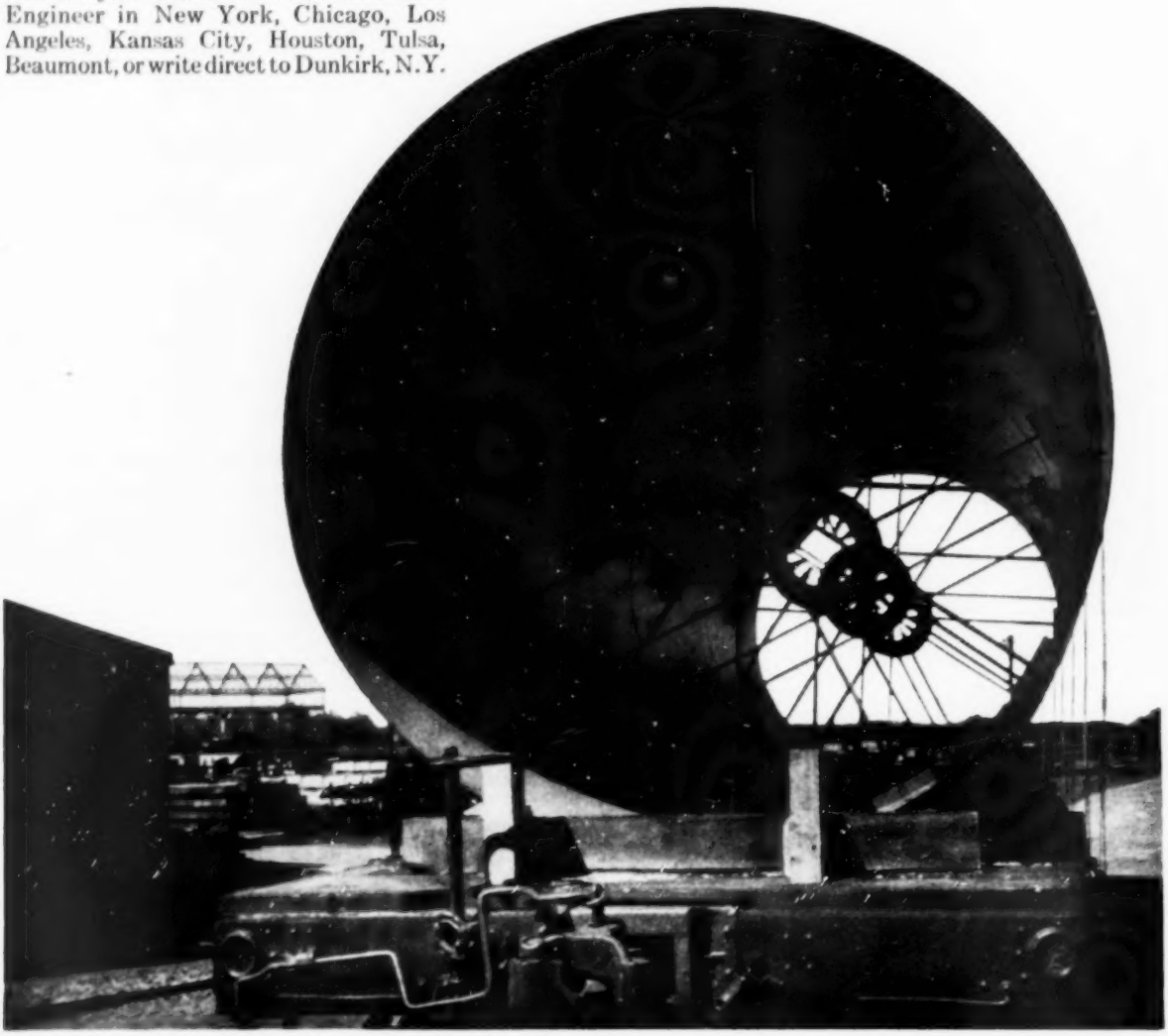
If you have a difficult metal-fabricating problem—a problem that challenges the imagination, that points to new equipment or offers new opportunities to cut production costs—we invite you to let Alco's facilities and experience produce the answer.

Contact your nearest Alco Products Sales Engineer in New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa, Beaumont, or write direct to Dunkirk, N.Y.

ALCO facilities

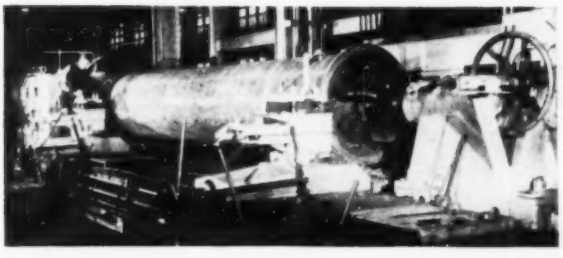
Answers to

TUNNEL INTERLININGS furnished by Alco in cold-rolled, carbon-silicon steel sections 40 ft long and 10 ft 6 in. in diameter will reinforce the outlet end of New York City's new $44,000,000 deep-rock East Delaware Water Supply Tunnel. Held to close dimensional limits, electric fusion welded throughout, they are the latest of many special piping sections fabricated over the years by Alco for New York water supply projects.

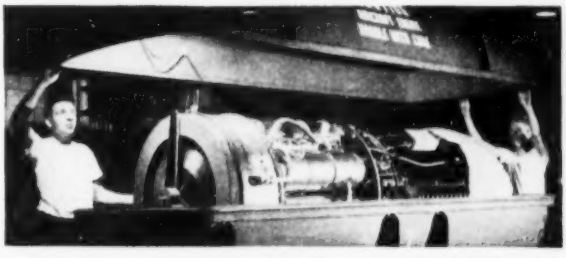


and experience produce...

New Industrial Problems



GIANT LATHE at Alco's 31-acre Dunkirk plant finishes and faces both flanges simultaneously on steel pipe up to 41 in. in diameter! Special machines like this, many of them Alco designed and all guided by the skilled hands of veteran craftsmen, help Alco solve the toughest of metal-fabricating problems.

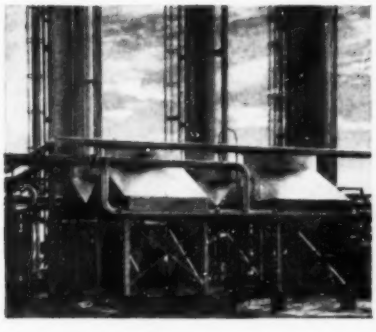


STEEL "CANS" FOR JET ENGINES, mass-produced by Alco, are carefully engineered to meet strict Air Force specifications. Example: they must "provide a barrier against the entry of water, dust, air and moisture *without* the aid of separately applied sealing compounds or materials."

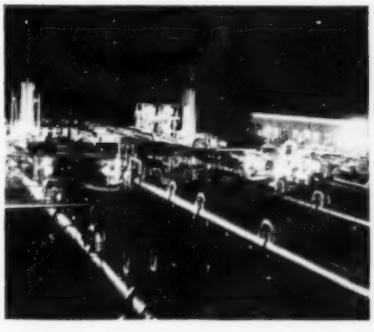
ALCO

ALCO PRODUCTS DIVISION

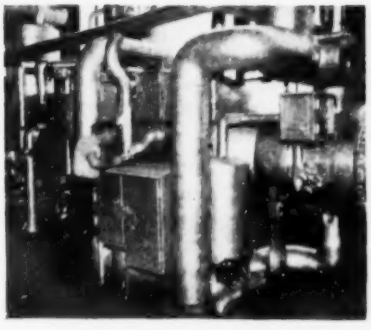
AMERICAN LOCOMOTIVE COMPANY • DUNKIRK, NEW YORK



"UNI-BUNDLE UNITS," with their specially fabricated steel headers, demonstrate the versatility of Alco Aircoolers. Vertical partitions welded in the headers allow several different vapor or liquid streams to be handled in a single tube-bundle. Here, for example, at a large Southwestern natural gasoline plant, the Alco Aircooler at right not only cools the oil but also condenses the overhead vapor from the stream.



"TRAIN" HEAT EXCHANGERS, designed and built of nickel steel by Alco for the Tennessee Gas Transmission Company's new gas processing plant (the world's largest) at Gabe, Kentucky, helped cut both installation and operating costs. Their flange-to-flange construction minimized the amount of connecting piping required, while their huge size (42 in. in diameter, 150 ft long) assured maximum processing efficiency.



SPECIAL ALCO FLEX-TUBE EVAPORATORS at the Carolina Power and Light Company's new 150,000-kw plant at Goldsboro, N. C., produce vapor containing not more than 0.5 parts per million of mineral solids, hold make-up to less than one-half of one per cent. With its patented Flex-Tube construction, this Alco evaporator offers industry a positive-acting thermo-mechanical descaling device for straight-tube installation.

100% TURBOGRID, the distillation tray that makes the bubble-cap tray obsolete

A new platformer unit, now on stream at Shell's Houston refinery, is the world's first to be 100% TURBOGRID® equipped.

The 12-column installation includes platforming and Shell Aromatics Recovery sections. The plant produces nitration-grade benzene and toluene, plus a xylene cut.

The columns range up to 163 ft. in height, with diameters up to 10 ft. 6 in. Their cost and performance is another proof that—

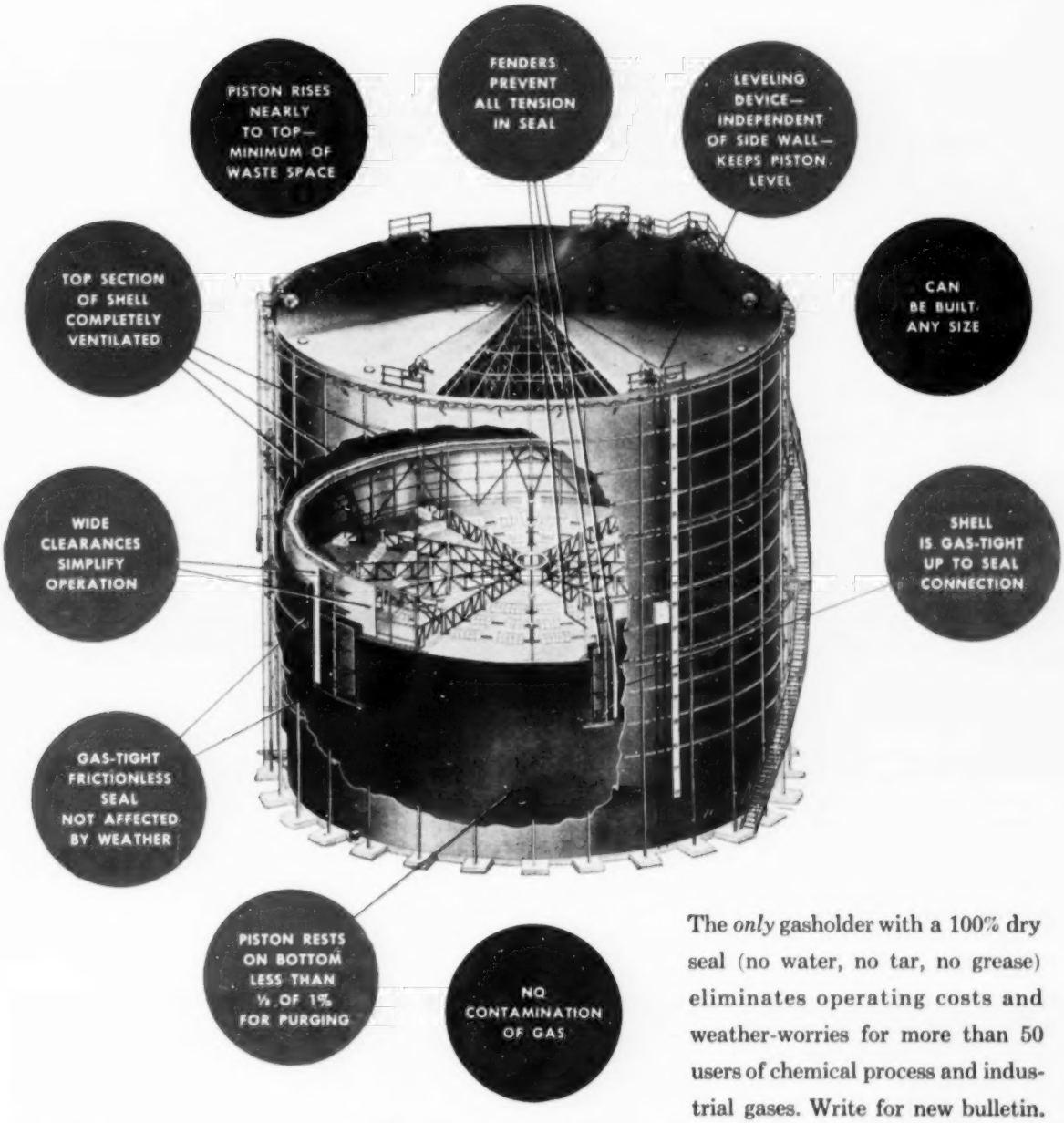
TURBOGRIDS SAVE MONEY, AND REALLY DELIVER

TURBOGRID trays can save as much as 50% in the cost of new column construction. Or, replacing your old trays with modern TURBOGRIDS may even double the capacity of existing columns . . . without loss in separating efficiency. Ease of control and operation plus low cost of maintenance . . . pay additional dividends.

TURBOGRID trays are available through accredited contractors under license from Shell Development Co. *Your inquiries are invited.*

SHELL DEVELOPMENT COMPANY
50 WEST 50th STREET • NEW YORK 20, NEW YORK

SHELL

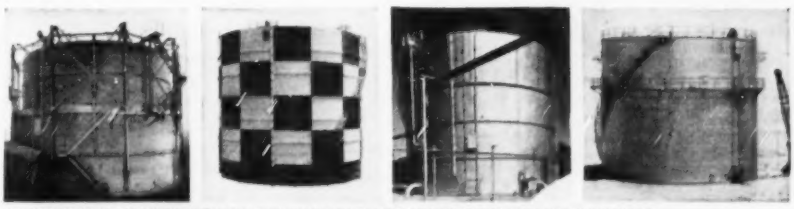

PISTON RISES NEARLY TO TOP—MINIMUM OF WASTE SPACE
FENDERS PREVENT ALL TENSION IN SEAL
LEVELING DEVICE—INDEPENDENT OF SIDE WALL—KEEPS PISTON LEVEL
TOP SECTION OF SHELL COMPLETELY VENTILATED
CAN BE BUILT ANY SIZE
WIDE CLEARANCES SIMPLIFY OPERATION
SHELL IS GAS-TIGHT UP TO SEAL CONNECTION
GAS-TIGHT FRICTIONLESS SEAL NOT AFFECTED BY WEATHER
PISTON RESTS ON BOTTOM LESS THAN ½ OF 1% FOR PURGING
NO CONTAMINATION OF GAS

The *only* gasholder with a 100% dry seal (no water, no tar, no grease) eliminates operating costs and weather-worries for more than 50 users of chemical process and industrial gases. Write for new bulletin.

Wiggins Gasholder by General American

CONVERSION EASY—OFTEN ADDS CAPACITY

Your old gasholder can be converted to a Wiggins type with all the Wiggins advantages.



WIGGINS VAPOR SEALS GENERAL AMERICAN TRADE MARK

GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South La Salle Street • Chicago 90, Illinois
OFFICES IN PRINCIPAL CITIES
In Canada: Toronto Iron Works, Ltd., Toronto, Ontario

(To obtain more data on advertised products see page 768)

Graphic Instrumentation . . . *from idea to installation*

SIMPLER supervision, greater operating efficiency . . . improved coordination . . . these are some of the contributions that graphic instrumentation is making in the process industries. Recognizing the ever increasing importance of graphic techniques, Honeywell offers complete engineering service . . . covering instrumentation, panel design, and construction.

Instruments

Tel-O-Set miniature indicators and recorders are supplied for temperature, pressure, flow and liquid level. They take a front-of-panel space only 5 inches square . . . fit readily into process diagrams. They meet the most critical demands for accuracy, simplicity, and utility.

Behind the panel are compact *Tel-O-Set* Controllers. They provide a choice of control actions.

Console desks, with integrally-mounted *ElectroniK* Precision Indicators, give operators a convenient means of monitoring a large number of critical temperatures.

For remote transmission, Honeywell has a full line of temperature, pressure, flow and level transmitters and receivers of both pneumatic and electric types . . . working with a broad selection of sensing elements.

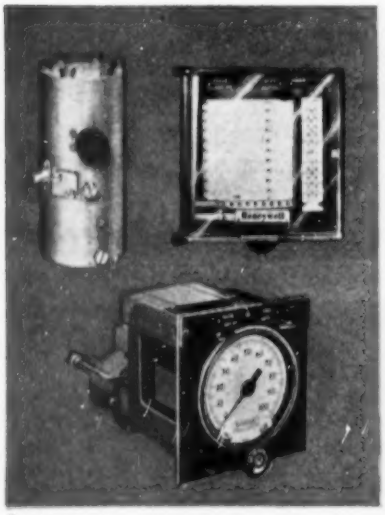
Panel Design

Every panel is custom-designed for its intended job by Honeywell's staff of panel engineers. After initial consultations, they develop a layout that fits all instruments, signals, remote control stations and other equipment in a coordinated design. All elements are located for greatest convenience and ease of manipulation. The overall appearance is made attractive and simple to follow, to aid in reducing operator fatigue. Final working drawings are prepared following consultation with the customer . . . then actual fabrication begins.

Panel Construction

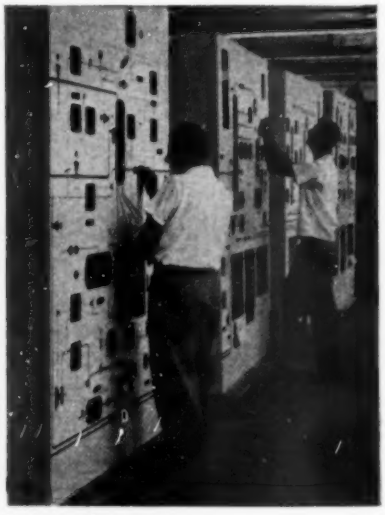
In Honeywell's shop devoted exclusively to panel production, skilled workmen do a complete assembly job. Every instrument, controller and accessory is mounted in place. All back-of-panel wiring and piping is completed, so the board is ready to connect to plant equipment. Before shipment, the entire panel goes through rigorous tests to assure trouble-free installation and start-up when the panel reaches its destination.

Efficiency- *for any*



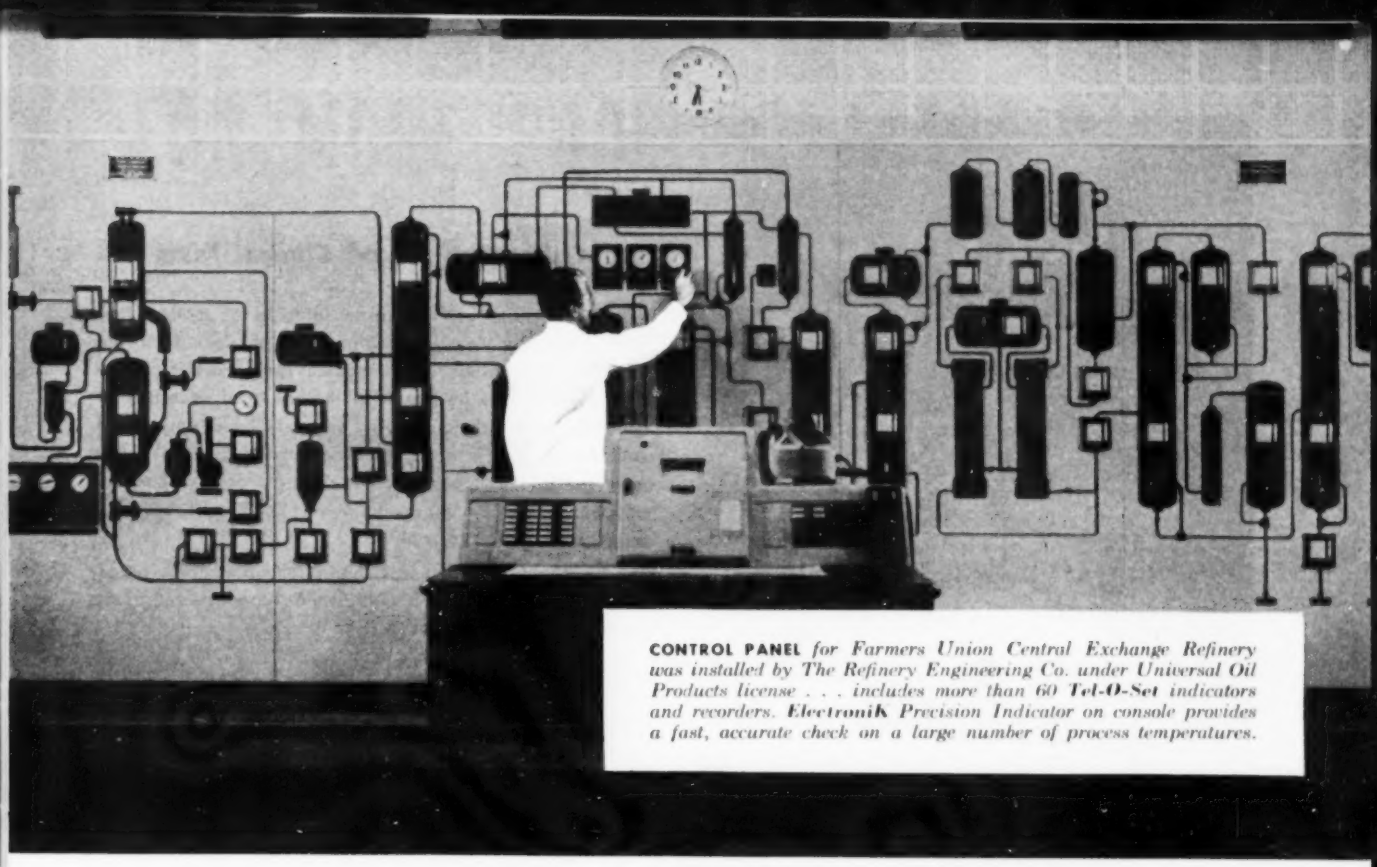
Instruments

Design



Construction

(To obtain more data on advertised products see page 768)



CONTROL PANEL *for Farmers Union Central Exchange Refinery was installed by The Refinery Engineering Co. under Universal Oil Products license . . . includes more than 60* ***Tel-O-Set*** *indicators and recorders.* ***Electronik*** *Precision Indicator on console provides a fast, accurate check on a large number of process temperatures.*

boosting graphic control *refinery, large or small*

THE operating economies of Honeywell centralized graphic instrumentation apply equally well to any refinery—whether it be an independent or one of the biggest producers. Take, for example, the panel shown above. Designed and built by Honeywell for the Farmers Union Central Exchange Refinery at Laurel, Montana, it has every feature of graphic control that advanced design can build into it.

The panel concentrates the operation of a 12,500-barrel-per-day plant, consisting of a fluid catalytic cracker, gas concentration unit and catalytic polymerization unit. *Tel-O-Set* indicators and recorders display every critical process variable for the guidance of operators. Every adjustment for shifting variables is right at the operator's fingertips—an important convenience for plants where market demands change frequently. *Tel-O-Set* controllers behind the panel do the "brainwork" of control—flexibly and accurately—keep all controlled variables accurately in line.

Attractive appearance of the panel aids in reducing operator fatigue . . . simplifies training of personnel. And functional design, both on the front and the back of the panel, speeds installation and service.

Expert design has made Honeywell graphic panels the choice of leading refineries and consultants throughout the world. Your local Honeywell engineering representative will be glad to discuss your own process control in detail . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4582 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Bulletin 85-20, "Centralized Instrumentation . . . unlimited."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

HELLIGE *CliniCol* COLORIMETER

Pre-Calibrated for 66 Clinical Tests

The Hellige "CliniCol" is indispensable to the modern hospital, institution, clinical laboratory, and physician for rapid bio-chemical analysis. This photoelectric colorimeter permits determinations to be made in the most advanced, most objective scientific manner . . . completely independent of comparison standards, light conditions and personal judgment. In fact, the simple 3-step operating procedure enables anyone, even without previous training, to make accurate and rapid determinations.

The handbook furnished with the instrument contains all 66 clinical tests in easy to understand language carefully prepared by experts.

H-14153. Complete with handbook, spare lamp, 3 square 13mm light path absorption tubes, volume control pipette for hemoglobin and red blood cell count, plastic cover and instruction manual. For operation on 115 volts, 60 cycles, a-c..... **$239.00**

(Pre-calibrated instruments with handbooks are also available for 90 tests at $274.00 and for43 tests at $189.00.

HELLIGE *Chromatron* COLORIMETER AND TURBIDIMETER

for Chemical Analysis, Process Control, etc.

The Hellige "Chromatron" is designed for accurate and rapid determinations based on the measurement photoelectrically of the color or turbidity of a liquid. The Chromatron can be calibrated easily and quickly for any of the hundreds of standard analytical methods published by such authorities as the A.S.T.M., the A.P.H.A., the A.W.W.A., etc. To use the instrument, a tube containing water is inserted and the meter set to 100. The tube is replaced with another containing the solution being tested and the percent of transmission is noted. Then the results are obtained directly from a calibrated graph.

HARSHAW

order from HARSHAW SCIENTIFIC

H-14150. Hellige Chromatron Colorimeter and Turbidimeter. Same general appearance as illustration above. Complete with spare lamp, internal disc with eight filters, three square 13mm light path absorption tubes, six round 10.8mm I.D. absorption tubes, plastic cover and instruction manual. For operation on 115 volts, 60 cycles, a-c. . . **$185.00**

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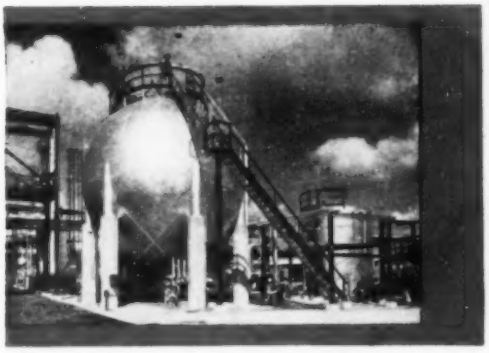
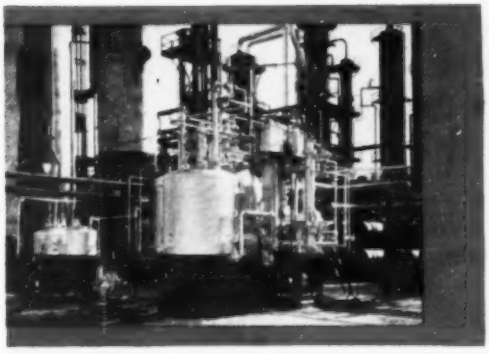
FOR MORE PROFITABLE REFINING

PETRECO
ELECTRIC PROCESSING



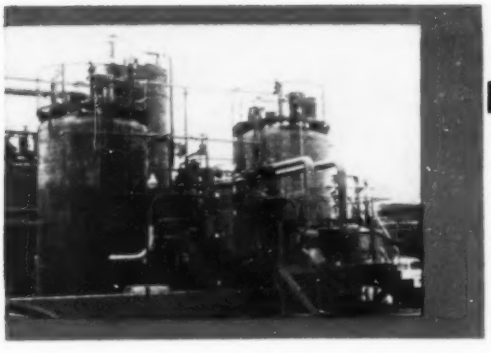
DESALTING

Petreco Electric Desalting eliminates salts, solids, and other impurities with such a high degree of efficiency that salt difficulties are eliminated — enabling refiners to run more crude.



DISTILLATE TREATING

Petreco Electric Distillate Treating takes the guesswork out of distillate treating. It is applicable to acid, alkali or doctor treating all distillate stocks. It permits continuous, automatically controlled treating with minimum equipment, handling and attention.



DESAPONIFICATION

Where caustic is added to crude prior to distillation, ash-forming materials resulting from such caustic are often present in fuel stocks. Petreco Electric Desaponification removes about 85% of such ash-forming constituents, enabling fuel stock to be marketed or to be used as a cracking charge.

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PETROLITE CORPORATION

PETRECO DIVISION

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PC 53-2

It takes a Giant to catch a Giant

IT'S always exciting to watch a little guy challenge a big guy—and win. That's why Jack the Giant Killer has topped the list of popular children's stories for centuries. And that's why we think the oil business is the most thrilling business in the world. It's a contest between Men and a modern Colossus.

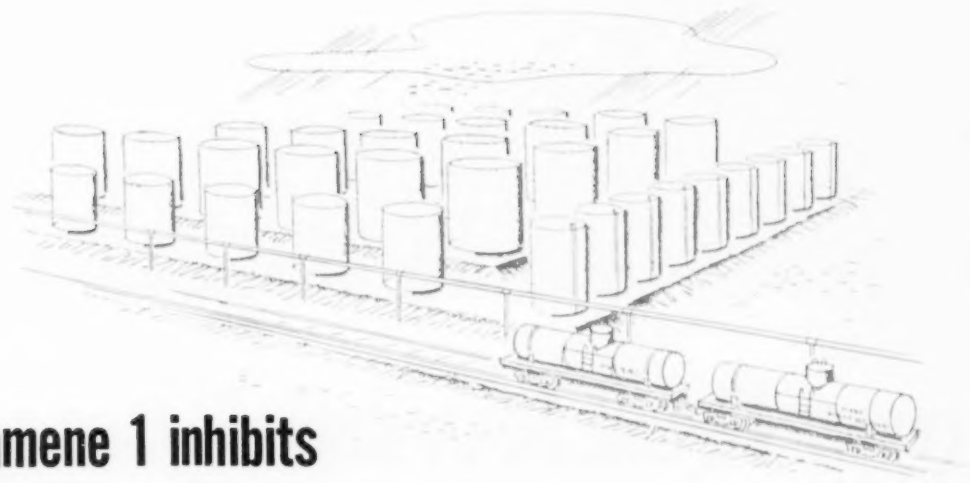
Not just any men. It takes men of tremendous initiative and daring—giants in their own right—to stalk the reluctant giant, Petroleum, drag him from his lair, civilize him, and put him to work.

Cities Service is well equipped with such men. Geologists who, at great personal hardship, track down the giant in his native haunts. Production men who risk all to bring him out alive. Refinery operations men, who domesticate and train him. Research men, who think of new ways to utilize his strength.

The mammoth muscles of petroleum have taken over some of mankind's hardest, most back-breaking jobs. We think a lot of credit is due the great-hearted Cities Service "Jacks" who've devoted their lives to finding, catching and domesticating this mightiest of modern "Giants."

CITIES SERVICE

Quality Petroleum Products



Tenamene 1 inhibits gum formation for as little as 2½¢ per barrel of gasoline

Tests under tough varying plant conditions show that Tenamene 1 is the most effective low-cost gum inhibitor known to the petroleum industry.

Refiners find that a little Tenamene goes a long way. In a typical case, only 5 pounds of Tenamene 1 are needed to treat 1000 barrels of gasoline—that's effective protection against gum for approximately 2½¢ per barrel!

If you're interested in general information about gum inhibiting as well as specific data about the Tenamenes, send for the booklets listed in the coupon. Our Petroleum Chemicals Laboratory will be glad to make tests and recommendations on any of your gum inhibiting problems.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave.

Tenamene **EASTMAN GASOLINE ADDITIVES**

Eastman
CHEMICAL PRODUCTS, INC.
KINGSPORT, TENNESSEE

Eastman Chemical Products, Inc.,
Chemicals Division, Kingsport, Tennessee

Gentlemen: Send me copies of your booklets: "Inhibiting Motor Fuels with the Tenamenes" and "Tenamene 2 Inhibitor Sweetening."

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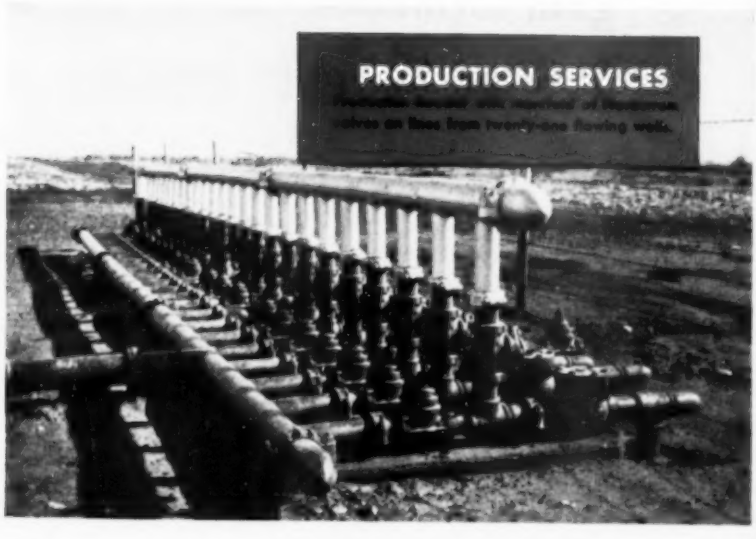
Sales representative for **TENNESSEE EASTMAN COMPANY,** division of **EASTMAN KODAK COMPANY**

How Rockwell Serves

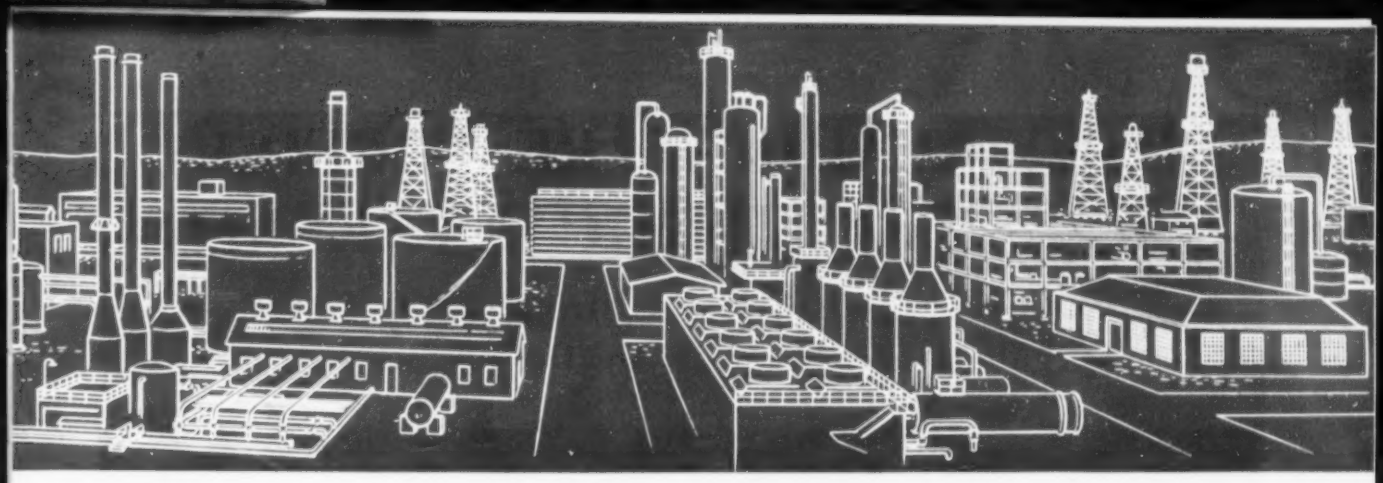
CHRISTMAS TREES

PRODUCTION SERVICES



REFINERIES

GASOLINE PLANTS



The Oil Industry...

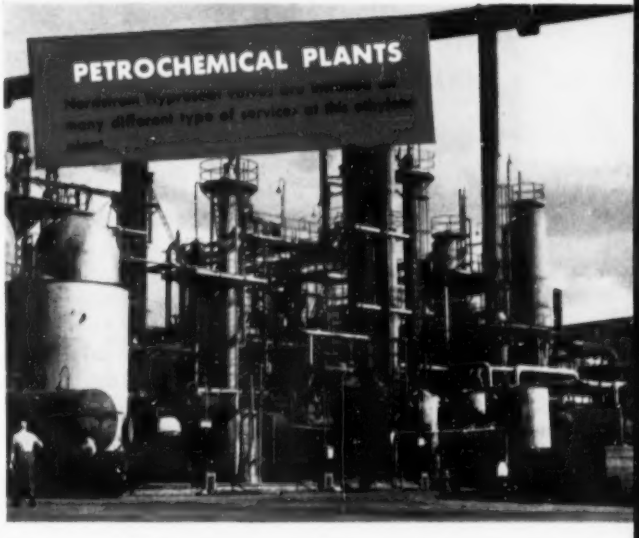
FROM WELL TO CONSUMER

Rockwell products have proven their efficiency in hundreds of applications throughout the Oil Industry.

Nordstrom Lubricant-Sealed valves, Rockwell Rotocycle meters, and Rockwell Industrial meters are in operation on all types of Oil Industry services requiring accurate measurement and control.

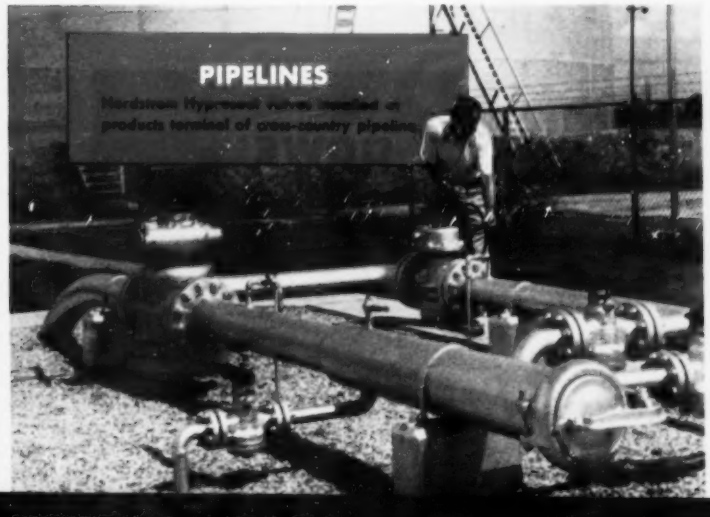
You are cordially invited to visit our exhibit* at the Oil Show in Tulsa. Courteous sales engineers will be on hand at all times to give you information on any product in the Rockwell line.

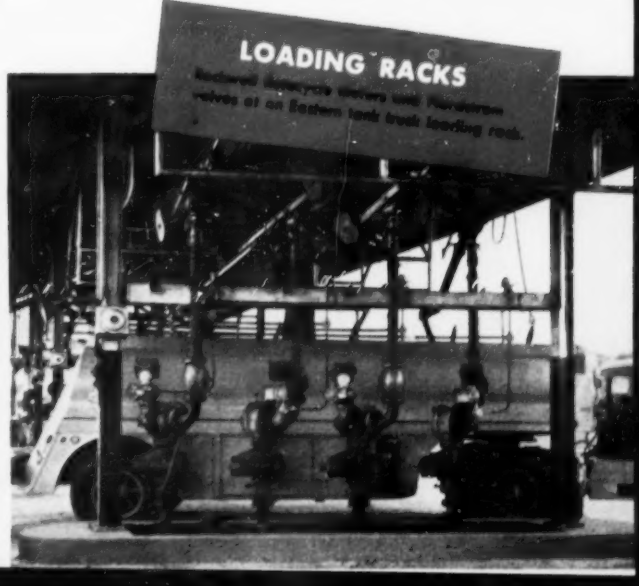
**Booths 33 through 38, Scientific and Technical Building*



ROCKWELL MANUFACTURING COMPANY

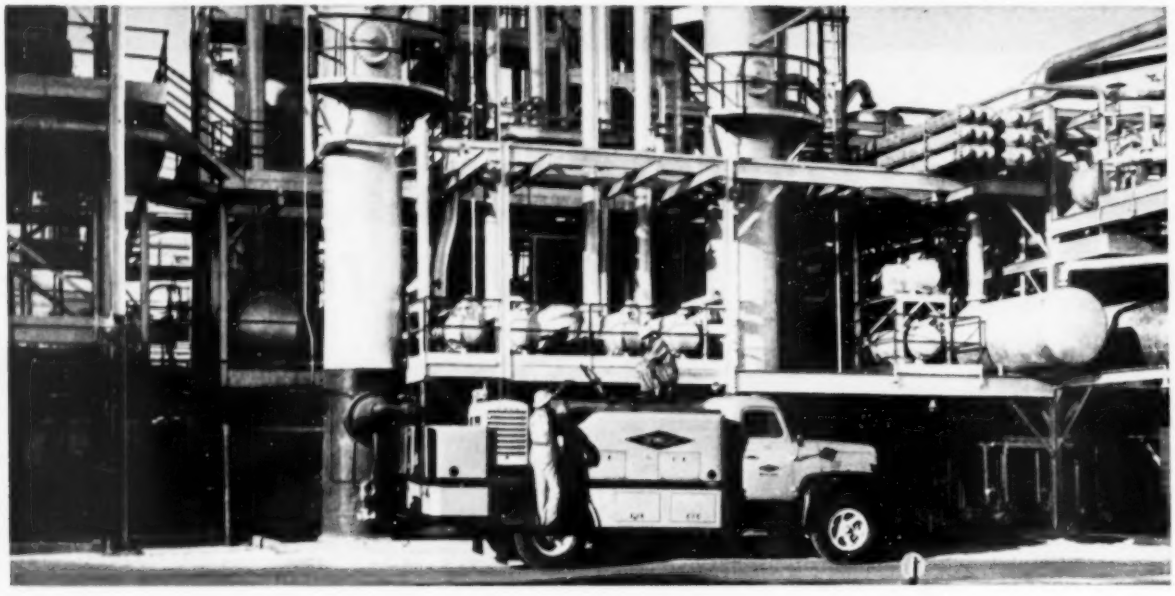
PITTSBURGH 8, PA. Atlanta Boston Chicago Houston Los Angeles
N. Kansas City New York Pittsburgh San Francisco Seattle Tulsa





TOWER CAPACITY RESTORED IN ONE DAY BY CHEMICAL CLEANING

Through-put increased from 500 to 800 gallons per minute by Dowell Service



The capacity of a fractionating bubble-cap tower, operated by a southern chemical company, had dropped from 800 to 500 gallons per minute. Heavy deposits covered the traps and clogged the bubble-caps. Dowell engineers analyzed these deposits and found them to be iron sulphides, oxides and organic material.

Dowell Service removed these deposits from the tower in only one day with specially prepared liquid solvents. Result: the tower was restored to its original 800 g.p.m. capacity.

In the Dowell method of chemical cleaning, solvents are applied according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Being liquid, they will go wherever steam or water will flow, reaching surfaces inaccessible to other cleaning methods. No special scaffolding is required. Dismantling and downtime are kept to a minimum. Experienced Dowell engineers do the job for you using Dowell-designed pump trucks and control equipment which are brought right into your plant.

Towers are just one of hundreds of pieces of industrial equipment which can be cleaned chemically by Dowell Service. For complete information and estimates on the cleaning of your equipment, call the nearest Dowell office, or write directly to Tulsa, Dept. E32.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

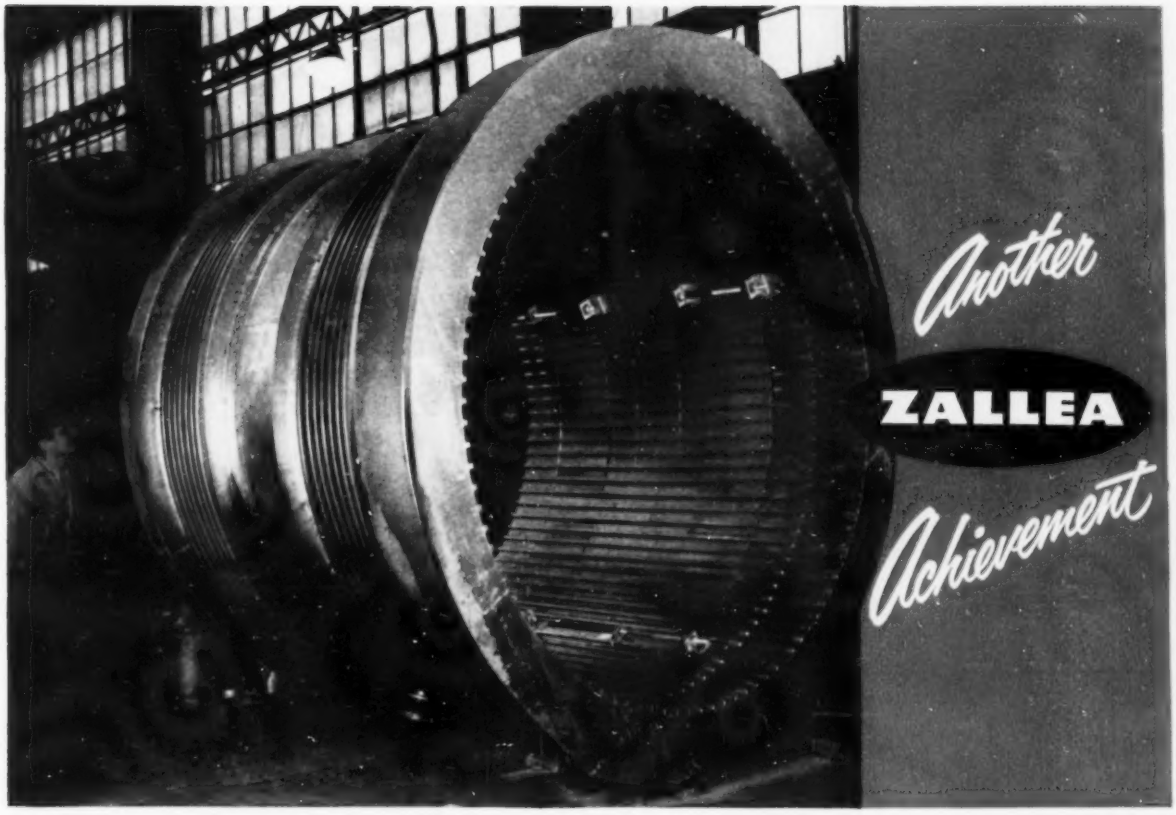
Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED · TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

(To obtain more data on advertised products see page 768)



In the almost quarter century that we have been in business, we have been called upon to develop and produce many highly specialized types of expansion joints. None, however, have been more spectacular than the 109-inch joints recently developed for use in testing equipment for aircraft engine prototypes. These low pressure joints were designed with a hundred internal tie bars, which permit the joints to absorb the lateral deflection between a long exhaust header, operating at 650° F. and a series of large gas coolers, without the need for heavy anchors. Eight of these joints are now in service in a classified defense project.

This is just another example of how Zallea engineers, with the experience gained from specializing in one product—expansion joints, are able to successfully and economically solve the most difficult problems confronting this type of industry.

But this is not all—we regularly manufacture a complete line of expansion joints capable of service in virtually any type of expansion application. These joints are available in diameters from 3 inches to 30 feet for temperatures from subzero to 1600° F. . . . for pressures from vacuum to 300 psi in standard designs and up to 2,000 psi in special designs.

For full details regarding your expansion joint problems or requirements, just get in touch with us. Zallea Brothers, 822 Locust Street, Wilmington 99, Delaware.

For detailed information on
Zallea Expansion Joints and services
write today for a free copy of Bulletin 351.

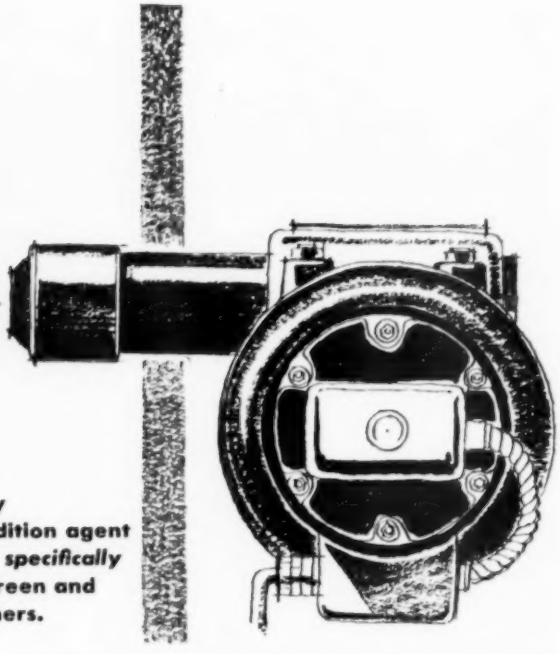
Zallea
EXPANSION JOINTS

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

(To obtain more data on advertised products see page 768)

Introducing...
SANTOLENE H

Stops Costly Screen and Filter Clogging of Oil Burners 4 Ways



SANTOLENE H is a newly developed Monsanto addition agent for distillate furnace oils *specifically designed* to overcome screen and filter clogging in oil burners.

1. **KEEPS FUEL OIL SLUDGE AND SEDIMENT LOW** by inhibiting progressive polymerization of unstable elements initially present in oil.

2. **REDUCES DEPOSITION** of sludge and sediment on burner parts by means of a unique surface action.

3. **INHIBITS RUST** and eliminates nearly all entrained rust at fuel oil burner.

4. **ELIMINATES OIL HAZE,** has no adverse effect on engine operation, is not subject to depletion by water extraction.

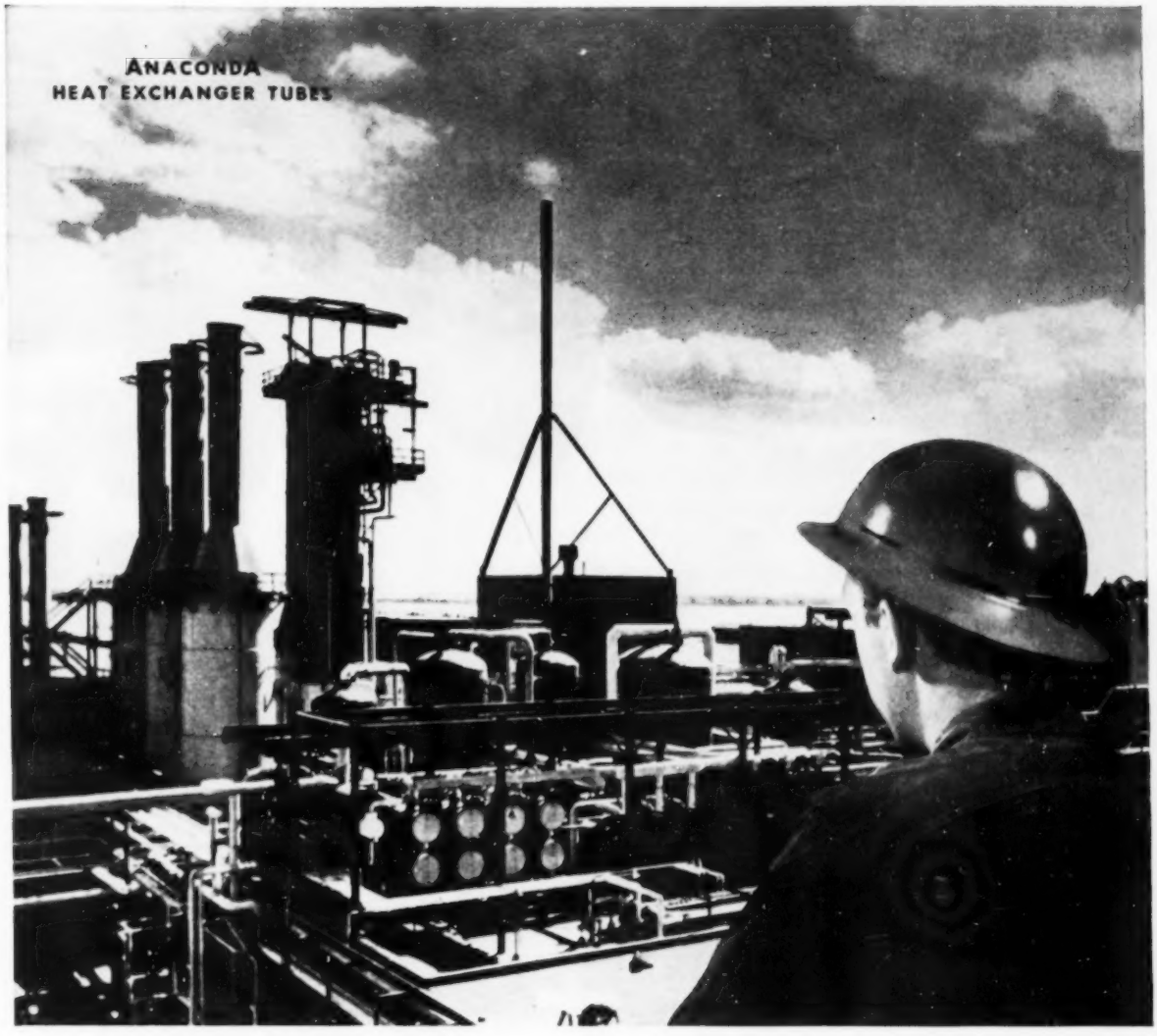
FOR MORE INFORMATION *send for Technical Bulletin O-87 to MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 N. Twelfth Blvd., St. Louis 1, Mo.*

SANTOLENE H

MONSANTO
CHEMICALS – PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

Santolene: Reg. U. S. Pat. Off.



AMBRALOY-927: FOR DEFENSE AGAINST CORROSION BY SEA WATER AND IMPINGEMENT

Pass turbulently flowing sea water containing air bubbles through a heat exchanger and you have as vicious an enemy as ever attacked a tube. This combination meets its match, however, in Ambraloy-927,* arsenical aluminum brass.

Ambraloy-927 tubes specifically resist corrosion by both salt and brackish waters under many operating conditions by quickly forming a protective surface film. This film resists the impingement of turbulently flowing sea water containing air bubbles and abrasive solids. The presence of arsenic in the alloy gives Ambraloy-927 its high resistance to dezincification.

If your refinery is dependent on sea water for its coolant, you will find that this Ambraloy-927 puts up a stronger defense against these particular forms of corrosion than Admiralty alloys. Our Technical Department's experience is always available to you for selecting the tube alloy that best fits your operating conditions. Draw upon it freely. And use the coupon below for your copy of an informative Anaconda publication.

for efficient heat transfer—

ANACONDA®

Heat Exchanger Tubes

**U. S. Patent No. 2,003,685 (ORIG.)*

The American Brass Company, Waterbury 20, Conn.
(In Canada: Anaconda American Brass Ltd., New Toronto, Ontario)

Send me publication B-2, "AnacondA Tubes and Plates for Condensers and Heat Exchangers"

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(To obtain more data on advertised products see page 768)

The first line of reducers is still the foremost line

T F

Old timers will recall the day—more than 20 years ago—when Taylor Forge announced the first comprehensive line of butt-welding fittings.

Before the WeldELL line was introduced, the only available welding fittings were elbows. But in the WeldELL line came all the fittings needed to do a complete and workmanlike job of pipe welding . . . the tees, reducers, caps, stub ends, and welding flanges.

To produce all of these types of fittings in seamless forged steel was a giant undertaking—and still is. A good example of this is the line of reducers. Today there are 175 reductions in standard weight reducers alone—and this can be multiplied by all the weights and materials in which Taylor Forge reducers are available.

The first line is still the foremost line—the engineered line, the full value line. For up-to-the-minute facts about the WeldELL line, see your Taylor Forge Distributor.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS

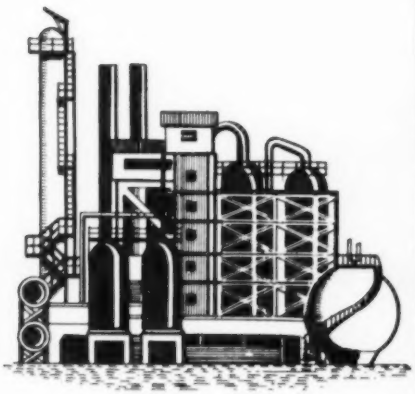
General Offices & Works • Chicago 90 • P. O. Box 485

Plants at: Carnegie, Pa., Fontana, Calif., Gary, Ind., Hamilton, Ont., Canada

9 REASONS WHY

KONTOL

is widely used in refineries



1. Kontol protects against attack by organic and inorganic acids, brines, hydrogen blistering and hydrogen embrittlement.
2. It is equally effective in the protection of steel, nickel and stainless alloys of steel, monel, brass and admiralty metal.
3. The Kontol protective film is stable and effective at temperatures up to 450° F. (Kontol itself is stable at 550° F. and more.)
4. Kontol has detergent as well as protective properties. In addition to protection against corrosion, Kontol also assures the advantages of operations with cleaner units and cleaner flow systems.
5. Kontol has no adverse effects on the properties of distilled products such as distillation end-point, gum formation, anti-knock rating, ash, etc.
6. Compared with the value of the metals it protects, and the labor costs of replacing them, the cost of Kontol protection is negligible.
7. Kontol is convenient and safe to handle, easy to apply. No gloves, masks, goggles, aprons or extraordinary safety precautions are necessary.
8. Kontol is available in a variety of formulas: oil soluble, oil soluble and water dispersible and water-soluble-oil-insoluble. In these forms, Kontol is suitable for injection into hydrocarbon systems, as well as in systems where the addition of hydrocarbon oils would be harmful.
9. The Tretolite Company's staff of corrosion engineers will assist you in the selection of the appropriate formula and its application to your problem.

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KONTOL
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TRETOLITE COMPANY

Chemicals and services for the petroleum industry

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DEHYDRATING · DESALTING · CORROSION INHIBITING · SCALE PREVENTING
PARAFFIN REMOVING · WATER DE-OILING

KR 53-2

(To obtain more data on advertised products see page 768)

In catalytic reforming

It's the CATALYST

That's why you should know the story behind the catalyst used in

CATFORMING

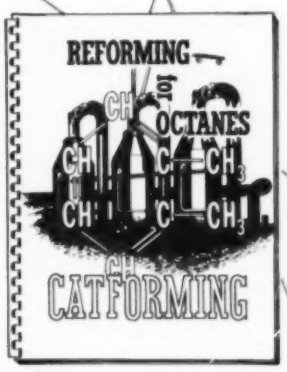
(To obtain more data on advertised products see page 768)

THAT COUNTS

Many years have gone by since catalytic reforming was first utilized by the petroleum industry. As with many developments, earlier methods fell far short of ideal.

Many years ago Atlantic's engineers and chemists looked well ahead to the more demanding needs of industry-wide commercial application. They devoted themselves to continuous and unrelenting laboratory research. One catalyst after another was rejected for failing to meet Atlantic's projected ideal catalyst. Finally, a catalyst possessing new characteristics and demonstrating an ability to surmount the shortcomings of previously developed catalysts was found. This completely new catalyst, combining the advantages of improved selectivity, greater stability, excellent resistance to poisoning, and easier regeneration, is the heart of CATFORMING.

CATFORMING is now in successful commercial operation, furnishing positive proof that IT'S THE CATALYST THAT COUNTS. You are invited to share the many benefits of CATFORMING by joining our ever-growing list of licensees. Call or write for our new detailed bulletin for your introduction to CATFORMING. The Atlantic Refining Company, Research and Development Department, P. O. Box 8138, Philadelphia 1, Pa. (Telephone, Howard 5-2345.)



This detailed bulletin yours for the asking!

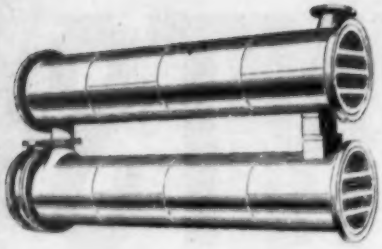
ATLANTIC

(To obtain more data on advertised products see page 768)

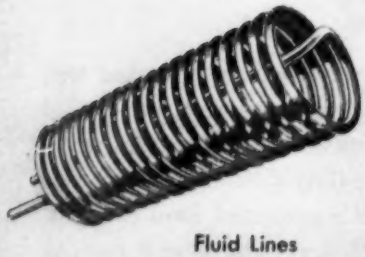
HAYNES Alloy Tubing

Trade-Mark

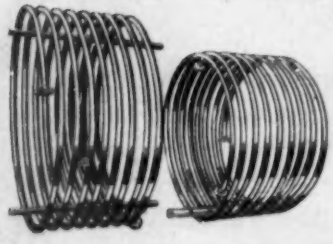
FOR SEVERE SERVICE CONDITIONS



Heat Exchangers



Fluid Lines



Coils

Tubing made of HAYNES alloys gives long, uninterrupted service under severe conditions of heat, corrosion, or oxidation. The tubing can be obtained in four different alloys, each having a particular combination of unusual properties to combat certain service conditions. The chart below shows some of the media these alloys resist. Typical applications are heat exchangers, coils, calandrias, and fluid lines.

All four HAYNES alloys are supplied in welded or welded and cold drawn tubing. Most common welding methods—including metallic-arc and HELIARC welding—can be used in fabricating the tubing installations. If you wish further information about HAYNES alloy tubing, contact the nearest Haynes Stellite Company district office.

USE TUBING OF	FOR RESISTANCE TO
HASTELLOY Alloy B (nickel-molybdenum-iron)	Hydrochloric acid, wet hydrogen chloride gas, sulphuric acid, phosphoric acid, organic acids, high temperatures.
HASTELLOY Alloy C (nickel-molybdenum-chromium-iron)	Nitric acid, free chlorine, acid salts, hydrochloric acid, sulphuric acid, phosphoric acid, organic acids, sulphurous acid, high temperatures.
MULTIMET Alloy (cobalt-chromium-nickel-iron)	Oxidation, high temperatures.
HAYNES Alloy No. 25 (cobalt-chromium-tungsten-nickel)	Oxidation, high temperatures, carburization, wet chlorine, nitric acid.

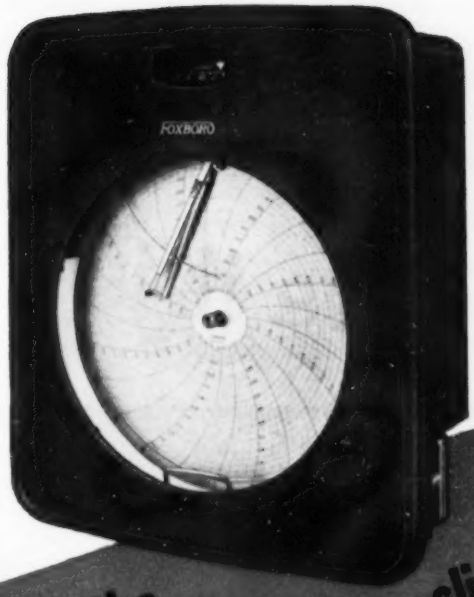
HAYNES alloys

TRADE-MARK

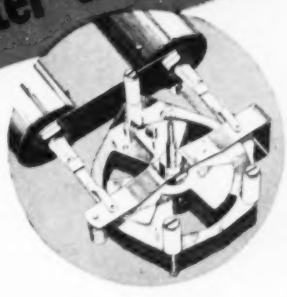
"Haynes," "Hastelloy," "Heliarc," and "Multimet" are trade-marks of Union Carbide and Carbon Corporation.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

An unbeatable pyrometer for any range between -300° and +2800°F.



DYNALOG* ... the electronic potentiometer that has no slidewire!



This simple variable capacitor is important to potentiometer users because it eliminates the conventional, troublesome slidewire altogether; and it gives Dynalog Instruments the continuous *stepless* balancing which assures higher accuracy, closer control.

*Reg. U.S. Pat. Off.

TOPS in simplicity . . . unequalled in its combination of accuracy, sensitivity, and speed of response . . . the Dynalog Potentiometer with standard thermocouples gives you unerring temperature measurement for any range up to 2800°F. Featuring *sustained* accuracy of ¼ of 1% of scale, it's an instrument of laboratory precision built to withstand the severest industrial conditions.

Unprecedented freedom from maintenance is the direct result of unique Dynalog design. There's no slidewire, no battery to standardize. There are no gears, belts, or high speed reversing motors. There's nothing to wear and cause dead space.

Single pen recording models provide full scale pen travel in 3 seconds standard, or as fast as 1 second without extra cost. The Multi-Record Dynalog provides color-coded records of up to 6 points at 6 second intervals. Both types give the convenience and low cost of circular charts.

Dynalog Potentiometers are also used for the measurement of pH, oxidation-reduction potential, and for other applications in which the process variable can be converted to a dc millivolt signal. They are available for pneumatic or electric control.

Write for your copy of Bulletin 427-1 which gives the whole story.

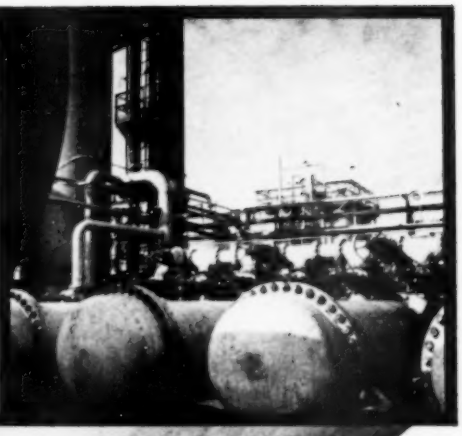
THE FOXBORO COMPANY, 915 NEPONSET AVE., FOXBORO, MASS., U.S.A.

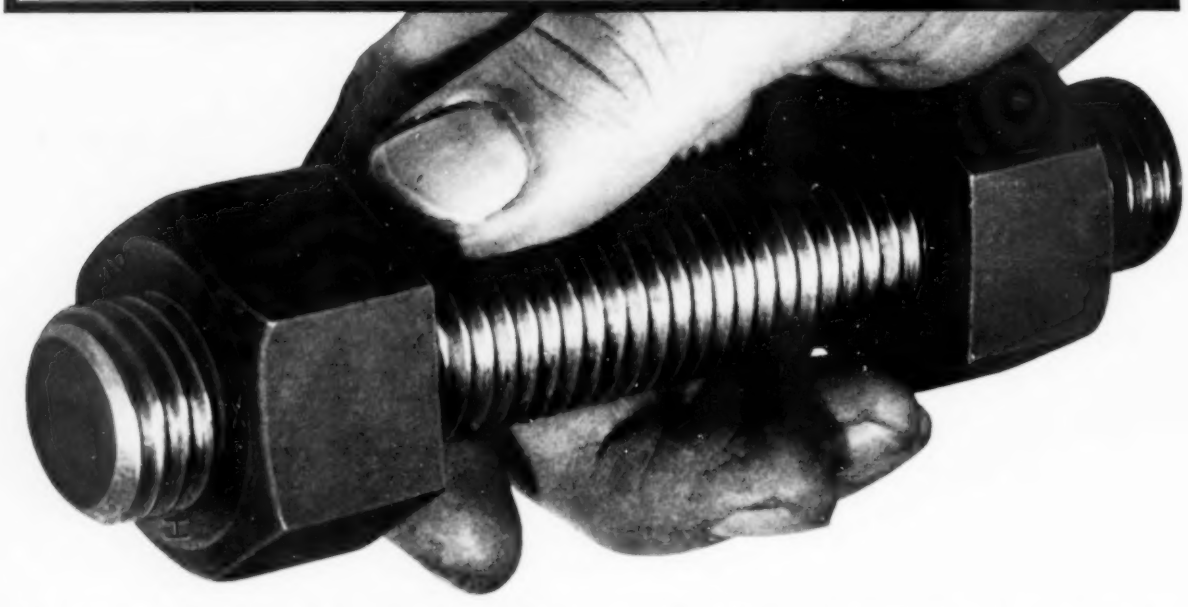
FOXBORO POTENTIOMETERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Looking for an Economical Bolting Combination?

Here it is





If you're looking for dependable fasteners for high-temperature, high-pressure bolting jobs, you'll surely like the combination of the Bethlehem Continuous-Thread Stud and two Bethlehem Quenched Nuts. This effective trio proves its economy in two ways: (1) It resists premature fatigue failure induced by fluctuating temperatures and pressures, and (2) It helps to minimize costly down-time.

Bethlehem Continuous-Thread Stud. Ideal for difficult bolting applications because it minimizes stress-concentrations. The stud has no point of thread-runout, therefore stresses cannot strike at any one point to cause premature failure. Instead, they are effectively distributed along the full working length of the stud. The continuous-thread stud is made from carbon or alloy steels, and comes either plain or heat-treated. You can count on it for long service.

Bethlehem Quenched Nut. Made from .40 to .50 carbon steel by forging and extruding hot steel in a forming die, then quenching and tempering. This process enables the nut to develop the full strength of any stud or bolt.

Both the Bethlehem Continuous-Thread Stud and Quenched Nut are made in a full range of sizes. They make a long-lasting bolting team. If you would like additional information about this bolting combination, the nearest Bethlehem office is at your service.

Made at Lebanon Plant... Key to Quality

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Bethlehem supplies every type of Fastener

Barrel Octanes from Houdriforming

WHEN YOU DECIDE ON HOUDRIFORMING
YOU KNOW WHAT YOUR YIELDS WILL BE
they're guaranteed

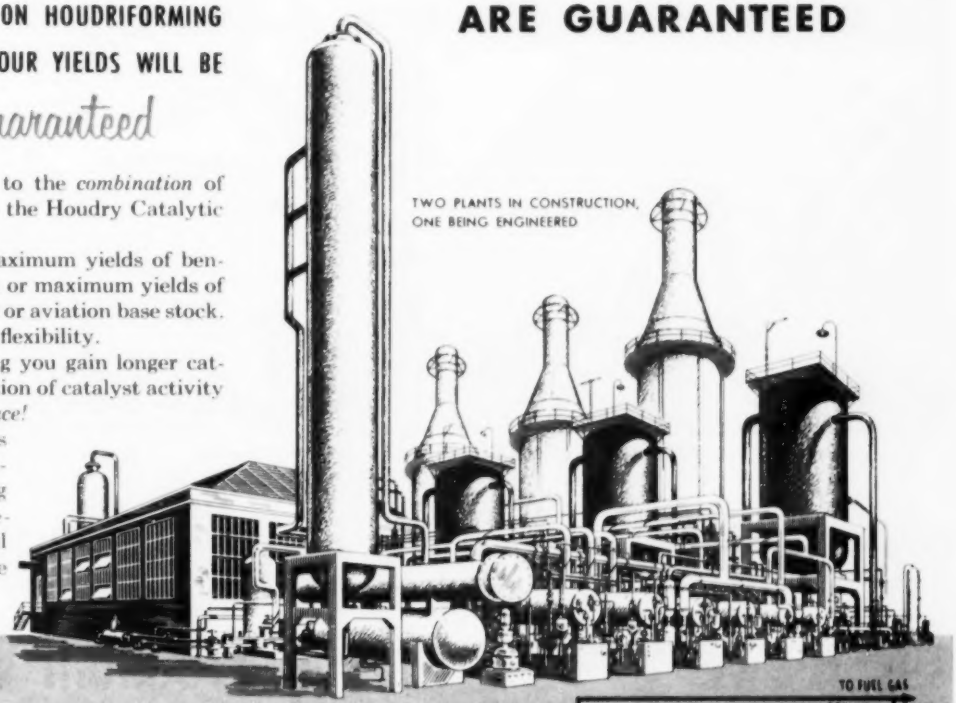
ARE GUARANTEED

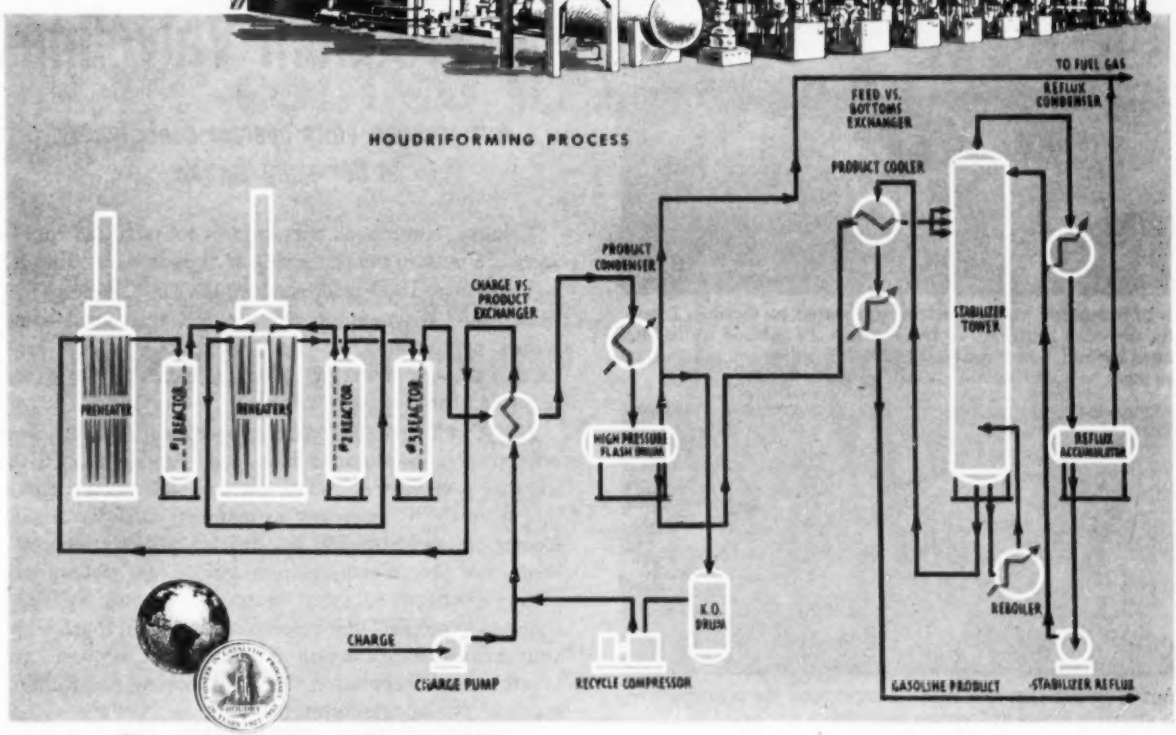
• There is no equal to the *combination* of advantages offered by the Houdry Catalytic Reforming Process.

You are assured maximum yields of benzene, toluene, xylenes; or maximum yields of high octane motor fuel or aviation base stock. Either with complete flexibility.

With Houdriforming you gain longer catalyst life, plus restoration of catalyst activity by regeneration *in place!*

Whether your plans for expansion or renewal of plant processing facilities are immediate or future, it will pay you to investigate Houdriforming.

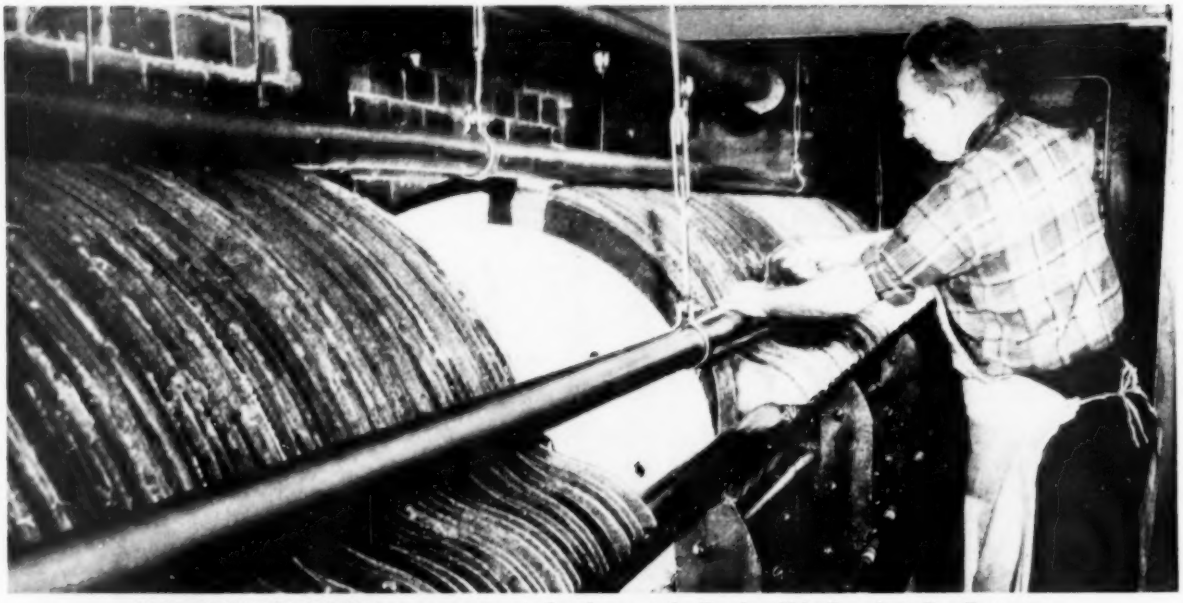




HOUDRY

PROCESS CORPORATION
1528 WALNUT STREET, PHILADELPHIA 2, PA.
International Licensors: World Commerce Corporation, S.A.
PIONEER in CATALYTIC PROCESSES

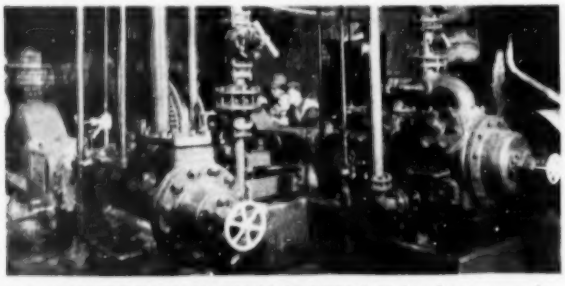
(To obtain more data on advertised products see page 768)



WAX PRESSES ARE STRIPPED once every twenty-four hours at the Freedom-Valvoline plant. Paraffin wastes are separated from wax distillate by chilling the distillate directly and removing the wax with a filter press.

Worthington equipment marks quarter-century at Freedom-Valvoline

WORTHINGTON REFRIGERATION EQUIPMENT at Freedom is used for dewaxing petroleum by two methods. In addition to the filter press method, wax is removed by chilling naptha solutions to precipitate the waxes and then centrifuging.



THIS WORTHINGTON AMMONIA COMPRESSOR has been operating in dewaxing service at Freedom since 1928.

Refrigeration units operate continuously in dewaxing service

Reliable, continuous operation of refrigeration equipment is a must in the processing of high-grade motor oils.

That's why the Freedom-Valvoline Oil Company has been using Worthington refrigeration equipment—ammonia compressors, boosters, brine pumps and heat exchangers—in dewaxing service at their plant in Freedom, Pa., for more than 25 years.

For more than half a century, Worthington engineered refrigeration installations have been serving leaders in industry everywhere. Today, the complete Worthington line is ready to meet any assignment, large or small. Remember, Worthington systems are all Worthington-*made*, not just Worthington-assembled. In addition to getting a perfectly balanced system, users benefit by Worthington's complete unit responsibility. Get in touch with your nearest Worthington district office, or write to Worthington Corporation, Air Conditioning and Refrigeration Division, Harrison, N. J.

A.3.58

Visit the Worthington Exhibit Building, corner Mid-Continent and Oklahoma Drives, Tulsa Oil Show.

Climate Engineers to Industry, Business and the Home

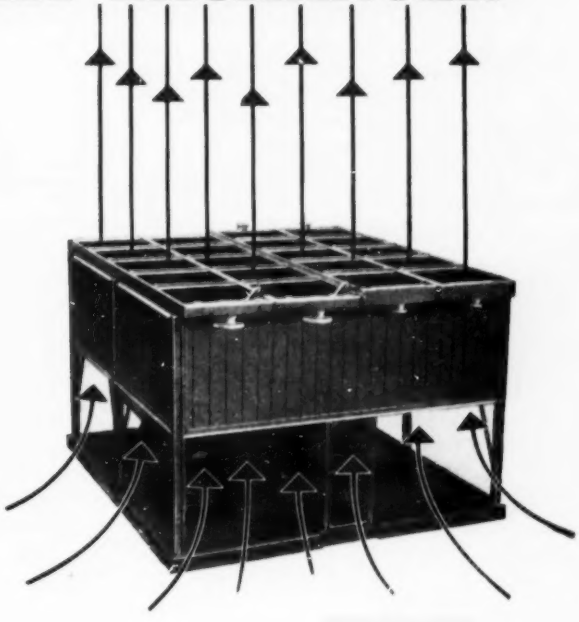
WORTHINGTON

Guaranteed Results

with the new

G-R fin-fan*

AIR-COOLED HEAT EXCHANGER



* *Improved design*
* *Wide application*
* *Dependable service*

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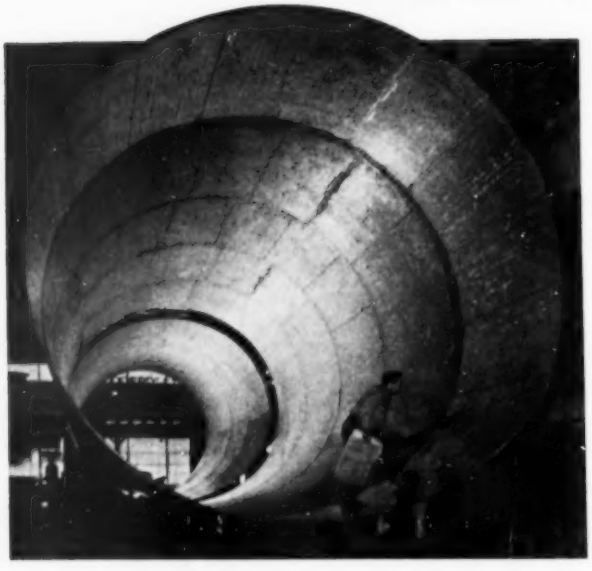
Designed, manufactured and serviced by

THE GRISCOM RUSSELL CO. · MASSILLON, OHIO

GR-314

When the Problem is HCl CORROSION ...look to MONEL for its Solution



IN DISTILLATION . . . Monel® has a high degree of corrosion resistance to the dilute HCl solutions formed in fractionation towers. It is used to line the upper portions of towers and for bubble caps and trays. Dephlegmators, condensers and condensate and reflux lines (and associate parts) are also frequently made of Monel. Monel clad or lined tops can be installed during tower fabrication, or linings can be made in existing equipment after repairs become necessary. Monel can easily be formed to vessel contours . . . is readily welded to itself and to the steel shell . . . large sheets can be used since the thermal coefficient of expansion of Monel approximates that of carbon steel.

IN ISOMERIZATION . . .

Monel is used where gaseous HCl and traces of water may combine to cause an unusually corrosive condition. It has found use in aluminum trichloride saturators, contactor separators, catalyst removal columns, vent gas scrubbers, hydrochloric acid stripper, catalyst strippers and reboilers for catalyst strippers.

IN ORGANIC CHLORINATIONS . . .

Chlorinators reaction vessels, coils and agitators are frequently made of Monel because of its high resistance to HCl corrosion. Monel's corrosion resistance also helps guard product purity.

IN PRODUCTION OF SYNTHETIC RESINS AND RUBBER . . .

Where HCl is used as catalyst or occurs as a result of hydrolysis, Monel is used for reactors, autoclaves, condensers and associated equipment such as valves, lines and fittings.

IN CHLORINATED SOLVENT RECOVERY . . .

Processors find Monel outstanding for resisting dilute HCl corrosion. That's one of the main reasons Monel finds extensive use in distillation and condenser equipment. Other components of the systems, pipe valves, tubing, etc., are also frequently made of Monel.

Monel is a superior structural material, too. It has high strength, good workability. Can be welded to form corrosion-resistant joints . . . can be machined, formed, bent . . . right on the job site.

Of course, there is no one metal, not even one Nickel Alloy, that can economically handle HCl corrosion problems under every operating condition.

That's why it's advisable to consult Inco's Corrosion Engineering Section. They have accumulated a vast amount of information that should help with a solution to your specific problems.

Just write, giving details . . . they will be glad to advise you. Address: The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Inco Nickel Alloys

INCO

Monel . . . *for minimum maintenance and replacement*

(To obtain more data on advertised products see page 768)

PETROLEUM CHEMICALS DIVISION

NEWS

May ★ One of a Series of Interest to the Petroleum Industry ★ 1953

What

are the advantages of buying gasoline additives from Du Pont?

1. **COMPLETE LINE**—Du Pont is the *only* supplier manufacturing a complete line of gasoline additives.
2. **EXPERIENCE** — Du Pont has had longer experience than any other U. S. company in making TEL (30 years). It has been making dyes for over 30 years; antioxidants 20 years and Metal Deactivator for 14 years.
3. **QUALITY** — Through the years Du Pont has set up quality control methods that are probably unsurpassed.
4. **TECHNICAL SERVICE** — To help refiners get the best results in the use of additives, Du Pont maintains *five* strategically located district laboratories.
5. **ECONOMY** — In many cases, the Du Pont district laboratories have been able to help refiners substantially reduce their cost of using additives.
6. **CONVENIENCE** — To assure fast, dependable deliveries, Du Pont maintains conveniently located warehouses, rail sidings and truck facilities throughout the country.

Petroleum Laboratory Has New Information On Deposit Formation

Until recently, there has been very little information on the reaction mechanisms which result in the accumulation of combustion chamber deposits—especially deposits formed by fuels containing tetraethyl lead.

Since nearly all modern automotive fuels contain tetraethyl lead, the Du Pont Petroleum Laboratory undertook a study of the sequence of chemical reactions which occur in engine deposit formation. The study is part of a continuing series of investigations on the mechanisms causing combustion chamber deposits.

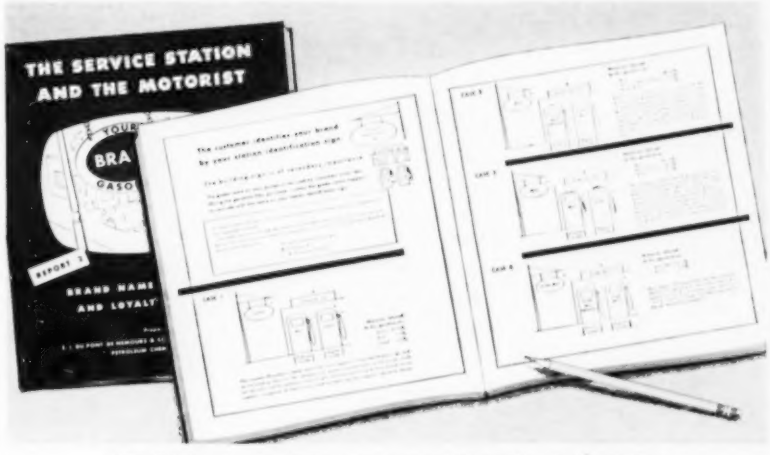
Briefly, the study revealed the following:

1. The course of deposit forming chemical reactions is dependent on the temperature of the combustion chamber walls.
2. Gaseous lead oxide, produced from the decomposition of tetraethyl lead, does not undergo vapor state reactions—except when the gas layer near a clean combustion chamber surface is cool.
3. Solid lead oxide which condenses has a short life as a deposit constituent. It is attacked by acid gases to form simple lead salts or reacts with the simple lead salts in solid state reactions to form complex lead oxysalts.

How Loyal are Service Station Customers to Your Brand Name?

Report No. 2 in Du Pont's survey of consumer buying habits reveals interesting statistics on brand name recognition and loyalty to brand

As an oil company executive, facts about your customers and potential customers are vitally important to you. They are the basis for sound advertising, sales promotion and marketing plans. The Du Pont survey of consumer gasoline buying habits is designed to help give you the facts necessary to perfect such plans.



THE DATA presented in these two pages of Report No. 2 show that a big majority of customers recognize the gasoline sold at a station by the name on the big identification sign erected in front of the station.

The survey itself is based on many thousands of customer interviews and service station observations. As such, it is too voluminous for easy distribution. It is, therefore, being broken down into a series of easy-to-digest reports in booklet form. The first of these reports—issued in March of this year—covered service station selection and loyalty.

WHAT'S IN A NAME?

Report No. 2—"Brand Name Recognition and Loyalty to Brand"—is now ready for distribution to oil company marketing groups. It contains a comprehensive discussion of motorists' loyalty to certain brands and *reasons* for their loyalty.

The tremendous sales power of your brand name is borne out by the survey. For example, the number of motorists loyal to a preferred brand is *greater* than the number loyal to a "usual" service station. And the degree of loyalty in length of time and in quantities of gasoline purchased is also greater. What's more, two out of three people

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED

Survey Report

say they buy a preferred brand *exclusively*.

These purchase habits are all documented and graphically illustrated in easy-to-follow form in Report No. 2 on the survey.

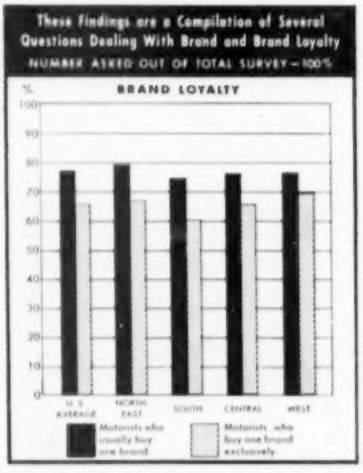
FACT OR BELIEF?

During the customer interviews, however, it was determined that many motorists base their choice of a gasoline brand—or prejudice against it—on *belief* rather than *fact*.

No product is purchased without the buyer's belief that it will satisfy his needs. Because of this, motorists are inclined to answer questions about gasoline brands in terms of brands that are *acceptable* to them.

On the other hand, people "believe," "think" or "have heard" that certain gasoline brands are of poor quality. In the survey 181 brand names and 3 brand groups received some mention as "a brand I would not buy."

A thorough study of replies showed that the reasons for acceptance are based almost entirely on quality *belief*. And the reasons for quality belief are nearly always connected with car performance. But service, friendship and station location were also mentioned frequently in addition to product quality as reasons for the motorists' purchase selection.



A TYPICAL CHART from survey Report No. 2. It shows that 77% of the motorists in the United States have a favorite brand and usually buy it . . . 66% buy one brand *exclusively*.

Central District Manager

EARL G. BENNETT, manager of the Du Pont Petroleum Chemicals Division central district, joined the Du Pont Company in 1931.

He was first assigned to the Grasselli Chemicals Department's Grasselli, New Jersey plant. He was later transferred to the Alcohol Division of the Organic Chemicals Department in Wilmington. There he did both technical work at the Jackson Laboratory and sales development work in connection with Du Pont's gasoline and lubricating oil additives.

In 1936, Mr. Bennett was assigned to special work with the Standard Oil Company of Indiana and The Pure Oil Company in Chicago on gasoline stability studies.

In 1939, he was transferred to Chicago in charge of sales in the western area for the Alcohol Division, which then included Du Pont's petroleum chemicals and dyestuff intermediates. He returned to Wilmington in 1943. In 1947, he was appointed Central District Manager, Petroleum Chemicals Division, in Chicago.

EARL G. BENNETT

He was graduated from Clarkson College of Technology in 1931 with a B.S. in chemical engineering. He is a member of the American Chemical Society, the Society of Automotive Engineers and the American Petroleum Institute.

BRAND NAME VS. GRADE NAME

An analysis of consumer buying habits also shows that there is little recognition by the motorist of gasoline "grade" names carried on service station pumps. In fact, motorists nearly always name gasolines according to the names carried on the big station brand identification signs. And the grade name is not a sales factor until after the decision to buy a certain brand is made.

The above are highlights of Report No. 2. More detailed information on grade choice will appear in Report No. 3, which is scheduled for publication sometime this summer.

Findings contained in these reports are based on 3,100 household interviews supplemented by 21,000 observations at 1,193 service stations.

National in scope, the survey is representative of gasoline buying patterns and trends throughout the country. We believe it is the most comprehensive market survey ever undertaken by any segment of the petroleum industry.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets and aids available to you through any Du Pont Petroleum Chemicals Division district office:

The Service Station and the Motorist — Report No. 1. An authoritative study of the four major gasoline marketing areas showing why motorists select certain service stations . . . and remain loyal to them Serial A-5396

Du Pont Fuel Oil Additive No. 2 — A 12-page bulletin describing this ashless stabilizer and dispersant that prevents clogging of fuel oil screens Serial A-5201

DU PONT
Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-5379

Printed in U. S. A.

X Marks a BIG Difference

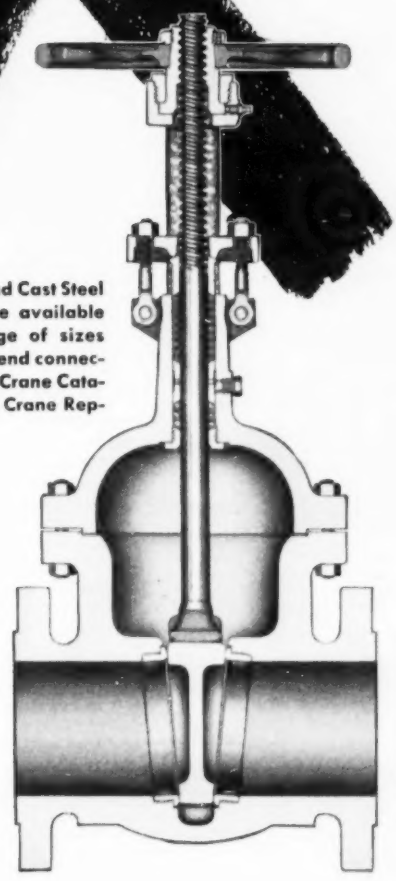
IN 300-POUND STEEL GATE VALVES

There's a lot of pioneering wrapped up in Crane 300-Pound Cast Steel Wedge Gates—pioneering that helped set the high quality standards every modern steel valve must meet.

Take Crane *Exelloy*—"X" trim—for example. In the early days of oil refining, many metal and metal combinations were tried for seating surfaces and found wanting. Crane *Exelloy*, adopted more than 25 years ago, set a new record of usefulness and satisfaction. So remarkable was its performance that this class of material (roughly designated as 11½ to 13 per cent chrome) became the recognized staple valve trim in the petroleum industry.

And yet, Crane still manages to come up with "X" trim of superior quality. It's done with bars and billets that meet the most rigid specifications—and manufacturing techniques that develop the best characteristic of material for each component part.

And it's you, the Thrifty Valve Buyer, who benefits from Crane Co.'s pioneering experience. You get better quality steel valves—quality that keeps up performance and holds down maintenance costs.



Crane 300-Pound Cast Steel Gate Valves are available in a wide range of sizes with 3 different end connections. See your Crane Catalog or call your Crane Representative.

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Blend 50,000 bbls. of gasoline in 2 to 3 hours

How much time is involved in blending gasoline in big tanks under your present methods?

You can cut this down—to as little as two to three hours for 50,000 bbls. of automotive fuel—with LIGHTNIN Series SE Mixers.

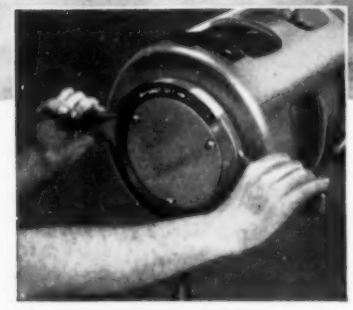
DO THE JOB WITH LESS HORSEPOWER—You can cut operating costs, too, because LIGHTNIN Mixers deliver as much as *ten times* the volumetric flow possible with other blending methods.

For example, to add TEL at 3 cc. per gallon to 65,000 bbls. of gasoline, you need only two 20-HP LIGHTNINS.

Their high pumping capacity sets up a constant, over-all flow in the tank, providing complete top-to-bottom turnover, eliminating dead spots, and assuring uniform viscosities.

RESULTS GUARANTEED—You can be sure LIGHTNIN Mixers will do the job *right*. Results are fully guaranteed—and based on years of research plus thousands of successful installations. LIGHTNINS are operating in tanks as large as 130,000 bbls. Many have been in continuous service 20 years and more.

SAVE ON THESE OTHER MIXING JOBS—You'll also save time and horsepower by using LIGHTNIN Mixers for blending lube oil, mixing charging stocks, liming re-run stocks, cutting back asphalt, controlling bottom sediment in crude tanks. To get *all* the facts, without obligation, just write us or mail the coupon today.



Easiest maintenance ever

New LIGHTNIN Model SE is easier to keep in operation than any other side entering mixer. Here's why:

1. **POSITIVE SHUT-OFF SEAL** permits repacking stuffing box without draining tank. Mechanical shut-off (shown) is easy to get at; eliminates wrenches.
2. **CHOICE OF STUFFING BOXES** (or low-maintenance mechanical seals) to suit your conditions.

FOR PETROCHEMICAL MIXING, hydrogenations, solids suspensions, high-efficiency stripping operations, LIGHTNIN turbine mixers offer complete adaptability to the process. Sizes 1 to 500 HP.

FOR CAUSTIC TREATING, feed water treating, preparing specialties, and dozens of other jobs, you can standardize on LIGHTNIN Portable Mixers. Thirty models. Sizes ⅛ to 3 HP.

Lightnin® Mixers

See you at the Exposition—May 14-23

LIGHTNIN Mixers—Booth No. 3, California Bldg.
LIGHTNIN Mud Mixers—at Dresser Industries, Inc., Exhibit

Get these helpful LIGHTNIN Catalogs

This library of mixing information is yours for the asking. Catalogs contain helpful data on impeller selection; sizing; best type of vessel; valuable installation and operating hints; complete description of LIGHTNIN Mixers.

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc.

131 Mt. Read Blvd., Rochester 11, N. Y.

In Canada: William & J. G. Greey, Ltd., Toronto 1, Ont.

- ☐ DH-50 Laboratory Mixers
- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet

Please send me the catalogs checked at left.

Name_____ Title_____

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Highlights of the API Meeting

An 11-page summary report on some of the most important subjects discussed by the Refining Division, May 11-14

New Refining Processes . . . . p. 683
Hydrogen Blistering . . . . . p. 686
Pressure Vessel Economics . . . p. 690
Electric Motor Lubrication . . . p. 693

Three New Refining Processes

Continuous lube oil decolorizing and two catalytic desulfurizing methods take spotlight at API Meet

COST and performance data reported on three recently developed refining processes—now at the point of, or already in, full-scale commercial application—indicate they can be considered competitive with existing processes in use today. As described in papers at the American Petroleum Institute's Division of Refining 18th Mid-Year Meeting in New York this week, the processes are:

1—A catalytic desulfurization process for distillates, requiring no external hydrogen-manufacturing facilities, the Anglo-Iranian Oil Co.'s "Autofining" process.

2—A continuous counter-current percolation technique for decolorizing lubricating oils and waxes, Socony-Vacuum Oil Corp.'s "TCP."

3—A catalytic desulfurization method using a "trickle" technique with liquid feed and a low hydrogen-recycle rate, developed by Shell Oil Co.

The Autofining Process

On stream since July 1952, at the Llandarcy, Wales, refinery of National Oil Refineries, Ltd., a 3500 b/d Autofining unit has been designed to operate on naphtha and tractor fuel feed stocks in blocked operation.

Sulfur removal, as indicated by typical operating data, has been 83.6% in the case of tractor fuel; 97.9% with naphtha; and 98.5% with kerosine. Runs of 1000 hrs. duration without regeneration have been attained on the tractor fuel. A minimum of 200 hrs. onstream time without regeneration had been the goal.

Investment costs of the 3500 b/d unit at Llandarcy amounted to $700,000, within battery limits. Of this, materials including building materials, drafting, engineering, procurement, and contractors' overheads, and profits account for about $550,000. Utilities consumption with operation at full design conditions has been 5000 lb./hr. (net) of 150-lb steam; 20,600 gph. (Imp) of cooling water; 25,000,000 Btu/hr. of fuel; and 10 kw of electric power.

The TCP Process

Lower investment cost than conventional static-bed percolation and lower operating costs than hot contacting were cited as the economic advantages of the TCP (Thermofor continuous percolation) process. Tested in pilot operations and a 500 b/d demonstration plant by Socony-Vacuum at Paulsboro, N. J., it has been engineered for a commercial unit with a capacity up to 8000 b/d. At present, a 2100 b/d TCP unit is nearing completion at Coryton, England, and a 3000 b/d unit has been licensed for erection in Holland. The Lummus Co. is contractor on both jobs.

Payout time just short of one year is estimated for a 3000 b/d unit, after depreciation at 8%/yr. and federal income tax at 50% of taxable income. This is based on a comparison with a hot contacting unit of similar capacity.

For example: investment cost for the 3000 b/d TCP plant comes to $951,200; for hot contacting it is $794,000; and for static bed, $2,515,000.

The incremental investment cost of TCP over hot contacting is paid out by lower operating costs and reduced lube oil losses. Operating costs (including lube oil loss) are as follows: for TCP, $698/day; for hot contacting, $1564/day; and for static bed, $1328/day.

Hydrodesulfurization

The trickle hydro-sulfurization technique of Shell is said to obtain savings of from 15 to 20% in capital investment and operating costs in comparison with gas-phase hydrogenation. Sulfur removal of 85 to 90% is attained with both catalytically cracked and straight-run gas oils. High octane gasoline—a by-product from the catalytically cracked cycle oil—and hydrogen sulfide contribute materially to the economics of the process, it is stated.

A commercial unit is now under construction at the Stanlow, England, plant of Shell Refining and Marketing Co. Ltd. Costs were estimated for a plant operating on 10,000 b/d of Middle East straight-run gas oil at $930,000 for investment, including the first catalyst charge and excluding process and engineering design. Operating on the same throughput of Middle East light catalytically cracked cycle oil, investment is $1,300,000. Operating costs with the straight-run gas oil were about 13.1c/bbl. of feed, and with the cracked cycle oil at 17.5c/bbl. feed for the same size plants. Sulfur removal was 85%.

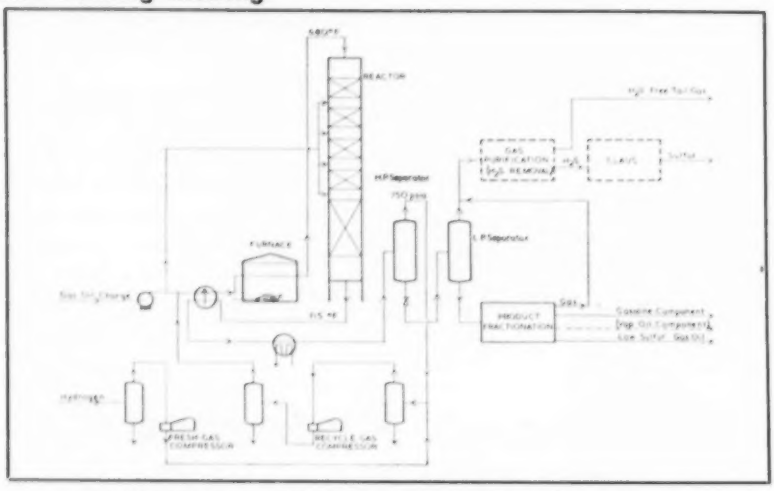

FIG. 1—Commercial trickle hydrodesulfurization process

Hydrodesulfurization Process

THE trickle hydrodesulfurization process is said to be suitable for a large variety of stocks. Because feed is not vaporized, high-boiling distillates—which would require excessive recycle-gas quantities for vaporization under the process conditions—can be desulfurized without difficulty.

The commercial unit under construction at Stanlow is shown in the simplified flow diagram in Fig. 1. Oil charge and fresh hydrogen, as well as recycle hydrogen, are combined. The combination is preheated by exchange with hot reaction products and then is heated in a small gas- or oil-fired furnace.

The reactor may contain a number of catalyst beds, between which cold charge oil is injected to take up the heat produced in the exothermic hydrogenation reaction. The number of beds required depends upon the sulfur content of the stock and the degree of sulfur removal desired. With low-sulfur stocks (say, 1 wt.-% or less), intermediate cooling may be omitted.

Reaction products after heat exchange with the feed, are cooled further and then passed to the high-pressure separator, from which—after the addition of make-up hydrogen—the gas is recycled. Liquid from the separator is flashed in a low-pressure separator and then passes on to a product fractionating section for removal of the remaining H_2S and light ends.

If desired, an engine-fuel type of kerosine component may be recovered. The low-pressure tail gas is, if desired, passed to a gas-purification plant for removal of H_2S. The latter may, for example, be subsequently converted to sulfur.

Typical design processing conditions for trickle hydrodesulfurization, operating on Middle East light catalytically cracked cycle oil, with cobalt-molybdenum-alumina catalyst:

Pressure, psia.	750
Temperature, ° F.	710
Liquid space velocity, vol/vol/hr	1.6
Recycle-gas rate, SCF/bbl.	1350

Sulfur content was reduced from 2.9 wt.-% in the feed stock to: 0.01 in the fraction under 430° F.; 0.02 in the 430-500° F. cut; 0.34 in the 430° F. plus cut; and 0.43 in the 500° F. plus fraction.

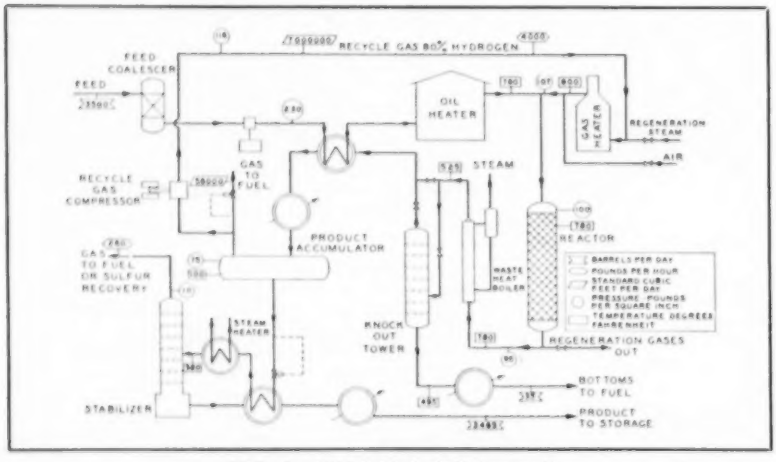

FIG. 2—3500 b/d Autofining unit

The Autofining Process

THE 3500 b/d Autofining unit at Llandarcy, put into operation last July, is illustrated in the simplified flow diagram in Fig. 2. It was designed to operate on naphtha and tractor fuel kerosine feed stocks in blocked operation.

The naphtha is an intermediate product of the Autofiner, which is subsequently distilled in conventional refinery equipment for special products, but the kerosine is obtained as a finished product ready for the market.

In operation, feed stocks and recycle gases (the latter predominantly hydrogen) are raised to reactor temperature in separate heaters. This is done for two reasons:

1—To reduce the pressure drop to be handled by the recycle compressors.

2—To restrict the use of stainless steel, which is necessary to combat corrosion from the hydrogen sulfide in the recycle gases.

Superheated vapors then pass downward through a bed of 7.4 tons of catalysts of the mixed-cobalt and molybdenum-oxides-on-alumina type. The reactor vessel is of mild steel, with a 4-in. internal refractory lining. Hot vapors from the reactor pass through a wasteheat boiler, where steam is generated and the vapor temperature reduced to near the dew point.

Products then pass into a knock-out tower, where approximately 1 to 2%-wt. of heavy ends are removed, an operation which can be controlled by reflux to the top of the tower. This step avoids separate re-running when correction of end point or color improvement is required. With naphtha feed stock, this step is not required.

After heat exchange and cooling, products flow to a separator from which the recycle compressor takes

suction. Excess gas is passed to the gas fuel main. Liquid product from the separator passes to a flash tower, where H_2S and other gases are removed and flash-point rectification can take place. A light, caustic-soda wash is given to guard against poor stabilizer operation.

Generally, all items of equipment in contact with recycle gas at temperatures above 500° F. are constructed from 18-8 chrome-nickel steel; the remainder of the equipment being of mild steel.

Initial runs at Llandarcy were on naphtha. External hydrogen is not required to start up the unit; refinery gas is recycled via the compressors and furnace to heat up the catalyst before naphtha feed starts. Thereafter, the volume of gas retained in the separator, which is purposely designed oversize, is sufficient to bring the unit onstream after regeneration.

Catalysts can be regenerated *in situ* with steam-air or inert gas-air mixtures. Process periods depend on the boiling range of the feed stock and the space velocities employed. With lighter feeds, regeneration is only required at intervals above 1000 hrs.; but with heavier stocks, such as Diesel oils, the intervals are reduced to 200 to 400 hrs.

Design conditions for the unit are:

Pressure, psig.	100
Reactor temperature, ° F.	780
Space velocity, vols oil/vols cat./hr.	3.0
Gas-recycle rate, SCF/bbl.	2000

Typical data obtained when operation was under the above conditions indicated that sulfur content of tractor fuel was brought down from 0.645 wt.-% in feed to 0.106 wt.-% in the product. In the case of naphtha for petroleum spirit production, sulfur wt.-% went from 0.143 to 0.003. With kerosine, sulfur went from 0.27 to 0.004 wt.-%.

A number of other details in operating results with Autofining were reported earlier.*

*"New Autofining Process." PETROLEUM PROCESSING, April, 1952, p. 467.

The TCP Process

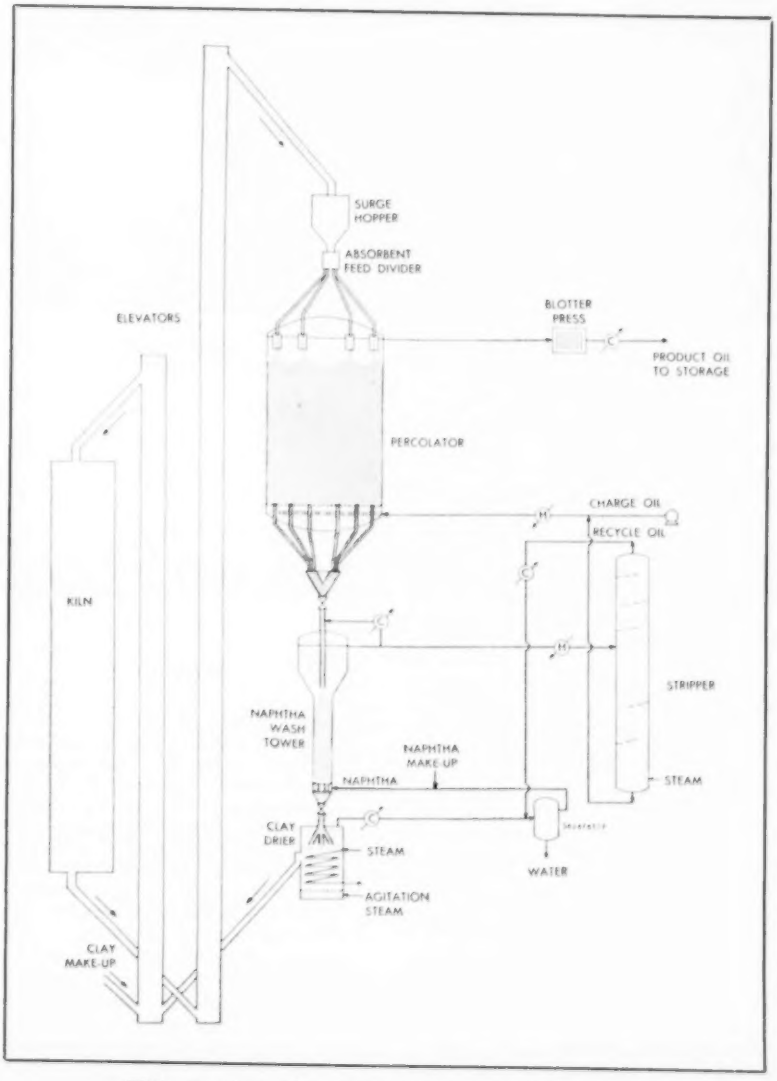

FIG. 3—Thermofor continuous percolation process

A THERMOFOR continuous percolation unit, illustrated in the schematic in Fig. 1, may be divided into a percolation section, a naphtha-wash section, and a regeneration section. The percolation section includes a decolorizing tower and its auxiliary equipment for feeding and withdrawing oil and clay. The naphtha-wash section includes a wash tower, with auxiliary equipment, and a clay drier. The regeneration section consists of a Thermofor clay-burning kiln, and the elevators and conveyors for transporting the clay.

Oil feed is preheated and enters the bottom of the percolation tower through a multi-nozzle distributor. Product oil is taken overhead through a blotter press to remove traces of entrained clay, and is cooled and sent to storage.

Regenerated clay from the kiln enters the percolator at the top and is distributed over the cross-section of the tower by a number of feed legs. It falls through the oil in the settling zone, and merges with the clay bed. Clay feed rate is adjusted to give the desired product color. Spent clay leaves via a multi-pipe drawoff system, its rate controlled automatically to maintain a constant bed level in the percolator. Approximately an equal volume of oil is discharged from the tower with the spent clay.

Gravity carries the spent clay to the wash tower, where it is washed countercurrently with naphtha in an operation similar to the percolation step. Overhead naphtha-oil solution is charged to a stripper for separation; stripped oil being recycled to the percolator and naphtha returned to the wash system. A portion of the overhead stream may be cooled and recycled, if necessary, to prevent boiling of naphtha by contact with the hot oil-clay slurry in the top of the wash tower. Bed level is controlled similar to that in the percolator.

Washed clay, containing some naphtha, enters a steam-coil heated drier, from which dry clay free of

naphtha is withdrawn continuously. The west clay is agitated by a small amount of steam or flue gas entering at the bottom. Sufficient heat is supplied by the coils to flash off the naphtha and permit withdrawal of dry clay from the top of the bed.

Heat-transfer rates up to 6000 Btu/hr/sq.ft. of coil surface were found practical, using 160-lb. steam in the coils. An experimental unit has operated satisfactorily at clay throughput rates up to 10 ton/day. Bed temperature is 350 to 400° F., making the clay moisture-free. By contrast, steamed clay obtained in conventional percolation usually contains 10 to 12% moisture, which has a tendency to deactivate the clay. Naphtha vapor from the drier is condensed and returned to the wash system. Dry spent clay is regenerated in the conventional kiln.

Operating data for the process, as obtained on three typical stocks in the 500 b/d pilot plant, showed yields ranging from 53 to 193 bbl. of oil/ton of clay. Stocks tested were SAE 30 mid-continent distillate and solvent-treated mid-continent bright stock of two different viscosities. Clay was 30 to 60 mesh fullers earth. These yields were 2.3 to 3.7 times the yields obtained with the same conditions on a plant size static bed percolation unit. Naphtha in the percolator charge ranged from 35 to 50 vol.-%. Color, ASTM, went from 8 or 7—in the charge down to 5 and 5—in the product.

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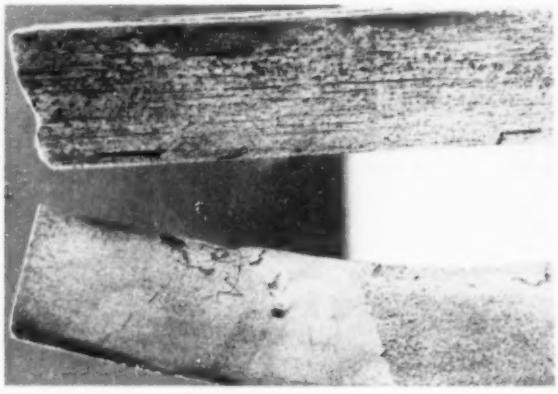
"Shell Hydrodesulfurization Process," H. Hoog, Royal Dutch Shell Laboratories, Amsterdam, The Netherlands; H. G. Klinkert and A. Schaafsma, Bataafsche Petroleum Maatschappij, The Hague, The Netherlands.

Three papers scheduled for presentation during the API Division of Refining's 18th Mid-Year Meeting, New York, May 13, 1953.



HYDROGEN BLISTERING and **ITS EFFECT—Fig. 1** (left) shows internal surface of severely blistered accumulator; **Fig. 2** (right) shows laminations and fissures resulting from hydrogen attack on condenser shell

WAR AGAINST CORROSION

Preventing Hydrogen Attack on Steel

By W. A. BONNER, H. D. BURNHAM, J. J. CONRADI
Shell Oil Co., Wood River, Ill.

and T. SKEI
Shell Development Co., Emeryville, Calif.

The use of modern refining processes and the greater handling of sour hydrocarbons have increased the vulnerability of steel equipment in refineries to attack by the atomic hydrogen released by acid corrosion of the steel. Extensive damage, through blistering and fissuring, can be sustained when streams containing ammonia and substantial amounts of hydrogen sulfide at a pH of 7 to 9 are processed.

Conditions necessary for the attack to occur and practical methods for operators to detect hydrogen penetration are given. New techniques for its prevention by use of ammonium polysulfide and oxygen as inhibitors are described. This presentation, to be given in two parts, is a condensed version of the original paper, presented before the 18th Mid-Year Meeting, API Division of Refining, New York, May 12, 1953.

Part 1

HYDROGEN attack on steel has caused extensive damage in a number of refineries. As discussed here, hydrogen attack is limited to that associated with aqueous corrosion in which the hydrogen penetrating the steel is a product of a corrosion reaction. This paper is not concerned with gaseous hydrogen attack on steel at high temperatures.

Two types of damage which can be sustained in refinery equipment are recognized. These are blistering (Fig. 1) and fissuring (Fig. 2).

Fig. 1 is a blistered area in an accumulator 6 ft. in diameter, fabricated from ASTM A-70 firebox-quality steel. This vessel had been in ser-

vice approximately 5 years prior to removal because of severe blistering. Blisters ranged in size up to 3 in. diameter and 28/64 in. deep in 1-in plate. Three of the larger blisters on the internal wall were drilled, and the gas in the blisters collected and then analyzed by the mass spectrometer. In each instance the gas composition was more than 99% hydrogen.

In Fig. 2 are shown two sections cut from a condenser shell fabricated from ASTM A-70 firebox-quality ⅝-in. steel. The laminations and fissures are 9/64 in. in depth. The condenser had also been in service approximately 5 years prior to its removal because of hydrogen damage.

Bend-test specimens were cut from the same vessel from which the specimens in Fig. 2 were taken. The type of failure shown in the bend tests demonstrated that, even in areas where no visible change has occurred, permanent damage to the steel may still exist, since the test specimens were cut from an area visibly free of blisters and fissures.

The mechanism of hydrogen penetration and its effect on steel in refinery equipment have been discussed in detail by Effinger and co-authors.[7] The present paper, covering more recent work, discusses the following topics in detail:

1.—Methods of detecting hydrogen penetration.

2.—Conditions necessary for attack to occur.

3.—Possible methods for controlling hydrogen penetration.

4.—Effect of polysulfide in laboratory experiments.

5.—Possible mechanism for action of polysulfide in stopping hydrogen penetration.

6.—Plant experience with polysulfide and oxygen injection.

7.—Permanent plant installation for control of hydrogen penetration.

1—Methods of Detecting Hydrogen Blistering

Direct Inspection of Equipment—Frequent internal and external inspection of all equipment subject to environments conducive to hydrogen attack is necessary because other detection methods fail at one time or another. External inspections of lines, especially lapwelded pipe, have located new blisters during operation. In other cases vessels have blistered externally, but by far the most extensive blistering in refinery equipment occurs internally. Several methods have been used to predict the occurrence of internal blistering.

Experience with Hydrogen Probes—Probes have been used extensively (7*) but they have not consistently indicated blistering conditions as evidenced by subsequent inspections. Location of the probes in the equipment appears to be critical. The following conclusions are based on our experience with probes:

1. A probe can indicate conditions only in its immediate vicinity. Thus an inactive probe does not necessarily indicate the absence of blistering conditions in other parts of the system. In addition, detailed conditions on the surface of the probe may be different from those on the vessel walls. A difference in condensation rate on the probe and on the wall because of a difference in temperature would be expected.

2. A probe showing continued undiminished activity for periods of two weeks or longer or high sporadic activity indicates that the environment is conducive to blistering, and should be viewed with alarm.

Sometimes probes are active following equipment bring-up, but generally the activity diminishes rapidly unless conditions favor continued activity. It is believed that any hydrogen damage resulting from start-up of equipment is at most relatively minor in comparison to the damage occurring in a continuously active system.

Direct Measurements of Penetration—Steel pads fitted with pressure gages for recording the amount of hydrogen penetrating the vessel wall have been welded on equipment suspected of being under hydrogen attack. In general, pads are much more difficult to install and not so sensitive. Therefore, they are not so useful as probes. They have more surface for collecting hydrogen, but the internal volume under a 1-ft. by 1-ft. pad is greater than in a probe.

Also the thickness of the vessel wall is many times the thickness of the reduced section of the probe. The proportionately greater volume of the patch decreases the rate at which hydrogen pressure builds up therein, and the greater thickness of the vessel wall compared to the probe wall results in greater time lag before any change in the activity of the system is observed.

Paint as an Indicator—One of the quickest and most sensitive methods of detecting an active system is to notice if the paint has blistered. For several days following the application of two heavy coats, some paints are impervious to the passage of molecular hydrogen. A rubber-base paint has been found satisfactory for laboratory purposes at room temperature; however, it has not been so satisfactory in plant trials.

This detection device was developed with the thought that areas of hydrogen penetration could be detected on equipment without probes. Patches were painted on equipment which exhibited probe activity, and wherever possible these patches were applied over areas where blistering was known to have taken place. In general, the results were discouraging because only one patch showed any evidence of blistering.

It is believed that failure was caused, at least in part, by the temperature of the equipment; i. e., the temperature caused rapid drying, with resultant loss of the impervious film. If a more impervious, slower-drying, or non-hardening paint were available, the painting of patches on refinery equipment might develop into a useful tool. Thus painting a small area opposite each tray of a column would readily locate those areas subject to hydrogen attack.

2—Conditions Necessary for Attack to Occur

A study of the conditions common to the occurrence of blistering in refinery equipment has disclosed the following six factors which usually occur simultaneously whenever blistering has been observed:

1. A steel surface subject to corrosion.

2. A source of reactive hydrogen.

3. A liquid-water phase.

4. An agent capable of poisoning the steel surface so that the formation of molecular hydrogen from atomic hydrogen is retarded.

5. Gross imperfections in the steel, such as a slag inclusion, a void, a discontinuity, or minute imperfections such as rifts within single crystals.

6. A promotor which maintains an active steel surface.

All common grades of low-carbon steel have been observed to be subject to hydrogen attack. In systems where appreciable quantities of hydrogen sulfuide are always present, a virtually unlimited source of reactive hydrogen is available. However, most inorganic and some organic acids may also serve as a source of reactive hydrogen for the corrosion reaction.

A liquid-water phase is necessary for the corrosion reaction to proceed. This agrees with the findings that hydrogen blistering and fissuring occur much more frequently in areas of absorbers adjacent to intercooler returns, condenser shells, and accumulators than in other types of equipment. Further, the lower temperatures which prevail during the winter would be expected to increase the amount of moisture which condenses from the hydrocarbon streams. Plant experience has indicated that hydrogen attack is aggravated during the winter months.

Atomic hydrogen is a product of the primary corrosion reaction:

$$Fe + H_2S = FeS + 2H^{\circ} \quad \ldots \quad (1)$$

A clean iron surface is normally a catalyst for the combination of hy-

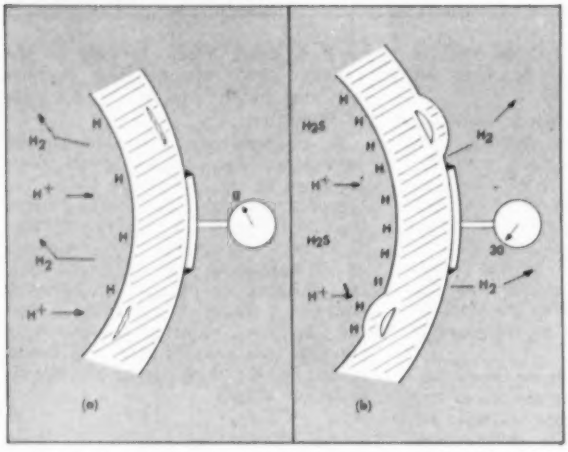


FIG. 3—Schematic representation of the disposition of atomic hydrogen from corroding steel surface in the absence of hydrogen sulfide (a) and in its presence (b)

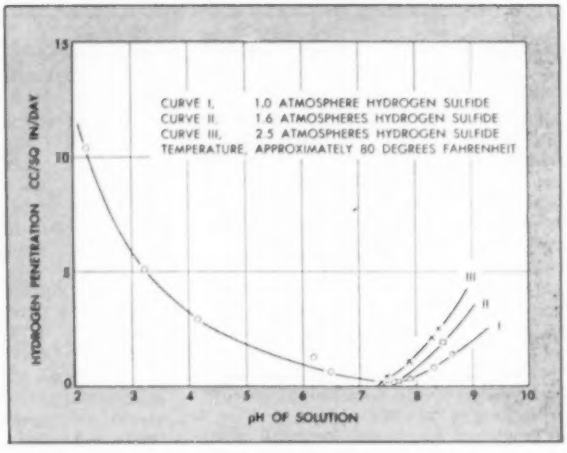

CURVE I. 1.0 ATMOSPHERE HYDROGEN SULFIDE
CURVE II. 1.6 ATMOSPHERES HYDROGEN SULFIDE
CURVE III. 2.5 ATMOSPHERES HYDROGEN SULFIDE
TEMPERATURE, APPROXIMATELY 80 DEGREES FAHRENHEIT
HYDROGEN PENETRATION CC/SQ IN/DAY
pH OF SOLUTION

FIG. 4—Hydrogen penetration rate measured with a standard probe as a function of pH for several partial pressures of hydrogen sulfide

drogen atoms to form molecular hydrogen. (Fig 3a):

$2H^{\circ}$ (surface of clean iron) $= H_2$ (2)

However, in the presence of hydrogen sulfide, the rate of combination of hydrogen atoms to form molecules is greatly reduced. As a result, high concentrations of atomic hydrogen accumulate on the steel surface. Because atomic hydrogen is slightly soluble in iron, and because it can diffuse through the iron lattice at random, many of the hydrogen atoms diffuse into the steel.

When slag inclusions, voids, discontinuities, or minute imperfections such as rifts exist within the steel, atomic hydrogen can combine at these points to produce molecular hydrogen. Molecular hydrogen continues to accumulate at these locations because the hydrogen molecule is too large to diffuse through the steel. Permanent damage to the steel is sustained if the equilibrium pressure exceeds the strength of the steel. The effect of the location of inclusions in the formation of internal or external blisters is illustrated in Fig. 3b.

If the reaction of iron and hydrogen sulfide continues without any interference, the reaction product, viz., ferrous sulfide, might be expected to slow the reaction of Equation 1 to only a fraction of the initial rate. However, there are several promoters which prevent iron sulfide or other reaction products from accumulating on the surface in a form, and in a sufficient amount, to slow the reaction materially.

Conditions Promoting Hydrogen Penetration — Three conditions have been found in refinery equipment which promote hydrogen penetration in the presence of hydrogen sulfide:

1.—Low pH.

2.—High pH, under anaerobic conditions.

3.—High pH in a system which contains cyanide.

High penetration rates are observed in low pH systems. As shown in Fig. 4, the penetration rate decreases as the pH is increased. A minimum penetration rate occurs at a pH of approximately 7.5.

In basic systems above 7.5 pH, and under anaerobic conditions, hydrogen penetration increases with pH and with hydrogen sulfide partial pressure. The effect of these variables is also shown in Fig. 4. Under these conditions ferrous sulfide formed on the steel surface is soft, is loosely held, and it readily sloughs from the corroding surface, thus exposing fresh surface for further attack. The presence of low concentrations of cyanide in such an active system does not increase the hydrogen-penetration rate.

In basic systems which contain high concentrations of cyanide, the ferrous-sulfide reaction product of Equation 1 is dissolved with the formation of ferrocyanide, Equation 3.

$$FeS + 6CN^{-1} = Fe(CN)_6^{-4} + S^{-2} \quad (3)$$

In this case the hydrogen penetration is especially high, and is dependent on cyanide concentration, so that the primary corrosion reaction is better represented by Equation 4.

$$Fe + 2H^{+1} + 6CN^{-1} \text{ (presence of } S^{-2}) = Fe(CN)_6^{-4} + 2H^{\circ} \quad (4)$$

To remove ferrous sulfide from the surface completely and obtain very high penetration rates in an all-steel laboratory system, the concentration of cyanide required was about 1.0 gram per liter. Such concentrations of cyanide are not usually encountered in refinery streams. In an all-glass system (except for the probe) substantially smaller amounts of cyanide gave a noticeable increase in penetration rates.

3—Possible Ways to Control Hydrogen Penetration

Hydrogen attack can be prevented by altering any one of the six general requirements for blistering previously discussed. It is impractical to change some of these conditions, but others have been studied and, wherever feasible, plant trials have been made.

Alteration of the Corroding Steel Surface—The vessel surface may be successfully protected from attack by the installation of expendable steel liners or by coating the interior walls of the vessel with ganister (1 part lumnite cement, 2 parts fine fire clay, 1 part coarse fire clay).

Steel liners are installed by making a one-pass continuous weld all around the periphery. A hole is drilled near the bottom edge of the liner to allow the escape of hydrogen. This is necessary for the reason that it is possible that the one-pass weld may be gastight. The possibility of making a gastight weld between the liner and the vessel wall and of venting to the atmosphere has been studied, but has not proved successful in practice.

Ganister linings have been installed over expanded metal in vessels where normal operating conditions maintain the pH above 7.0. If the pH in the system falls below 7, ganister is rapidly attacked. Laboratory experiments have shown ganister to provide complete protection against hydrogen penetration as long as the lining is intact.

None of the ganister linings in service have been removed for inspection of the vessel wall, but inspection of the ganister linings in two separate vessels after a year of service showed them to be in good condition.

Four types of proprietary coatings have also been tested in the plant.

These coatings—three organic, and one inorganic—were applied to sandblasted surfaces and cured according to the manufacturer's recommendations. All of these coatings failed because of peeling or disintegration in less than 10 months of normal plant operation.

Elimination of Source of Reactive Hydrogen—Elimination of compounds which contain reactive hydrogen prior to compression is not practical when such large quantities of gases as are ordinarily processed by the Wood River refinery are handled. All hydrogen-sulfide and other acid gases would require removal from the processing stream. At some locations in the gas-recovery plant, hydrogen-sulfide partial pressures of 100 psia have been recorded.

As an example, approximately 50 tons of hydrogen sulfide per day are produced with the catalytically cracked gases. This would require 84,000 gal. of 20° Baume-caustic soda solution per day, assuming 100% utilization of the caustic.

A regenerative process for the removal of hydrogen sulfide and for the recovery of the sulfur would require a separate gas-treating plant.

Elimination of Liquid-Water Phase—There is ample evidence in the literature that complete drying of the process stream would eliminate corrosion and hydrogen penetration. Norton used a sensitive ionization gage to detect hydrogen penetration,[8] and he found that hydrogen did not diffuse into the steel tube when water vapor alone surrounded it. Camp also found that the presence of liquid water was necessary for the appearance of any appreciable corrosion in processing materials in the presence of hydrogen sulfide at low temperatures.[5]

If the gas streams are dried, it is likely that salts such as ammonium carbonate may be deposited in some of the columns and result in plugging. Provisions for both washing and drying would require excessive equipment. Further, the complexity of our gas-recovery plant-feed system is such that several washing and drying facilities would be required. Therefore, this method of protection did not appear economically attractive, and was not attempted.

Elimination of Poisoning Agents—Removal of agents which poison the steel surface and retard the formation of molecular hydrogen (Equation 2) is another method for stopping hydrogen penetration. Only a trace of these agents is required as a catalyst poison; and, once the steel surface is poisoned, the removal of these agents is difficult. Acid cleaning only partly removes the catalyst poison. Sulfide ion is an efficient catalyst poison, and its complete elimination from the system would require the removal of all of the hydrogen sulfide—and this has already been shown to be impractical.

Effect of Cleaner Steels on Occurrence of Blistering—Cleaner steels (such as ASTM A-201, grade "B") were suggested by a well-known fabricator of refinery equipment as a means of reducing hydrogen damage. In general, clean steels are as subject to fissuring as are so-called "dirty" steels in which blisters provide a warning of impending failure. In steels which blister most severely, the distribution rather than the total amount of slag determines the blistering characteristics.

In one instance, an accumulator was fabricated from three sheets of steel from the same heat. This vessel, installed horizontally, was found after several years' service to be so severely blistered as to require replacement. Blisters were encountered only in the two end sheets. Trepan samples of the blistered and unblistered plates were taken for metallographic study. The photomicrographs of these samples shown in Fig. 5 indicate that the distribution of slag in the blistered plate is strongly oriented. This orientation is parallel to the surface of the plate.

In cleaner grades of steel, particularly those in which the slag is very uniformly distributed, fissuring and embrittlement are of major concern. Fissuring is more difficult to locate than is blistering, and the depth of penetration is harder to determine. Inasmuch as blister formation serves as its own warning, no attempt is made at the present time to reduce hydrogen attack by specifying cleaner grades of steel.

Effect of Temperature on Solubility of Hydrogen in Steel—The solubility of hydrogen in steel increases with temperature, and solubility also increases with the partial pressure of the hydrogen.[10] Armbruster investigated the solubility of hydrogen over a 20,000-fold range of hydrogen pressure,[1] and concluded that the solubility is proportional to the square root of the pressure of hydrogen. This result is exactly what would be expected if the actual species which dissolves in the metal is atomic hydrogen rather than molecular hydrogen. Armbruster found that all of the experimental data for pure iron up to the A_3 transition point can be represented very closely by Equation 5:

$$\text{Log}\ \frac{C}{P^{1/2}} = \frac{-1{,}454}{T} + 1.946 \qquad (5)$$

Where:

C = the solubility of hydrogen, in micromols per 100 g. of iron.
T = the absolute temperature, kelvin.
P = the pressure of hydrogen, in millimeters of mercury.

Further, the solubility of hydrogen in low-alloy ferritic steels was found to be essentially the same as that in pure iron; whereas, in an austenitic steel, the solubility is four or five times as great as that in pure iron, or about the same as in pure nickel.

The important feature of the relationship expressed in Equation 5, from the standpoint of damage to equipment, is the rapid change of solubility with temperature. Thus, a piece of sound steel, charged at an elevated temperature with a quantity of hydrogen not quite capable of rupturing the steel, on rapid chilling would be subject to an enormous internal pressure. Such an effect has been recognized for some time in the heat treating of steels, where a hydrogen atmosphere is used in the annealing oven to reduce scaling.[11] Slow cooling of hydrogenation equipment and reactors which have been subjected to hydrogen atmospheres is also established plant practice. Actually the effect predicted by Equation 5 becomes very large in the neighborhood of room temperature. Thus, a reduction of temperature from 150° F. to 32° F. would produce a 100-fold decrease in the solubility and, in turn, a 100-fold increase over the aerostatic pressure at which the metal had been charged at the upper temperature. Although this effect of temperature is a possible mechanism in blister and fissure formation, the occurrence of blistering or fissuring as a consequence of temperature fluctuation has not been demonstrated in plant experience.

Mitigation of Hydrogen Penetration by Organic Inhibitors—Organic corrosion inhibitors have been tested both in laboratory and plant applications with little success. In laboratory work a number of proprietary inhibitors were tested for their effectiveness in the prevention of hydrogen penetration. Such inhibitors, when used in the recommended concentrations, or even in many times the feasible concentrations, failed to protect test coupons against blistering for significant periods of time.

Even if organic inhibitors could stop blistering in areas which are continuously in contact with liquids, some special means would have to be used to provide for the distribution of the inhibitor to areas normally in contact with vapors, e.g., in columns and accumulators which do not run liquid-full. This is also true with respect to any inhibitor which has a low vapor pressure under the specific conditions when such an inhibitor is used, or if the inhibitor is not formed *in situ* from volatile components.

All techniques for controlling hydrogen penetration described up to

this point have either failed or have been only partly successful.

Practical Method for Controlling Hydrogen Blistering—It was observed in laboratory experiments that high hydrogen penetration rates through steel could be maintained in basic systems only under anaerobic conditions. Whenever polysulfide was added to ammonium-hydrosulfide, solution, or when traces of oxygen were allowed to react with the solution to form polysulfide, corrosion and hydrogen-penetration rates immediately dropped to practically zero. Further experiments showed that cyanide ion reacts with polysulfide to form thiocyanate, and that the hydrogen-penetration rate, consequently, returns to its former value.

This led to the hypothesis that the occurrence of hydrogen blistering in the plant resulted entirely from the relative concentrations of cyanide, and of polysulfide and oxygen, in the process stream. Laboratory experiments to prove this hypothesis, as well as plant experiments utilizing both polysulfide and oxygen to control hydrogen penetration, have been completely successful. This theory resolves the erratic and unexplained behavior of systems in which traces of oxygen were inadvertently present or in which aerated water had been used for washing various plant streams.

The balance of this paper is devoted to a discussion of the laboratory and plant experiments, and to the chemistry involved in the control of hydrogen penetration by polysulfide, and will be published in a subsequent issue.

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DETERIORATION OF METALS

Relative Costs of Alternate Types Of Reactor Vessel Construction

*From a Report**

By I. E. BOBERG and W. R. FICKETT

Chicago Bridge and Iron Co., Chicago, Ill.

SOME economic aspects of pressure vessel design as influenced by a consideration of graphitization of the metal at elevated temperatures are presented, through the medium of studies of the first cost of alternate types of construction of reactors of catalytic cracking units.

The studies include both field-erected and shop-built vessels. Consideration is given to designs where internal insulation is employed, permitting design temperatures of not more than 650° F., as well as designs utilizing external insulation only and employing unit stresses prescribed for these elevated temperatures by the *API-ASME Code for the Design, Construction, Inspection and Repair of Unfired Pressure Vessels for Petroleum Gases and Liquids*. Stated assumptions are made relative to the cost of insulations, stress relief and radiographing.

The types of pressure vessel construction studied, the type and amount of insulation used and other factors were selected by the Study Group on Deterioration of Metals, of the Subcommittee on Unfired Pressure Vessels of the Committee on Refinery Equipment of the API Refining Division.

The trend is toward the consideration of graphitization-resistant construction for such vessels, even at some increase in first cost, it is brought out. Within limits, such increase might be considered as insurance for the refiner. The occurrence of graphitization is not always predictable in advance and, in many cases, the financial loss resulting from an enforced shutdown is so great that a relatively unpredictable risk cannot be justified.

Vessel Selection and Evaluation

Two vessels were selected for comparison, viz., one to be field-erected and one to be shop-built. In order to obtain the picture over a range of temperatures, it was suggested that all comparisons be made at three temperatures: 900° F., 950° F., and 1000° F.

Each vessel has also been evaluated for three types of construction, as follows:

1—Mild steel, with internal insulation, to reduce the steel temperature to not more than 650° F.: The diameter of the vessels under this alternate has been increased 10 in. in order to provide the same net capacity inside the insulated surfaces.

2—Mild steel, without internal insulation, utilized at the unit stresses permissible under the *API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* for the specified metal temperatures of 900° F., 950° F., and 1000° F.

3—A graphitization-resistant steel (ASTM A-301, grade "B") without internal insulation, utilized at the unit stresses permissible at metal temperatures of 900° F., 950° F., and 1000° F. This steel contains 1% chromium and ½% molybdenum.

In the selection of the mild steels for alternates (1) and (2), the lowest-

Steel Temp. °F.	650	900		950		1000	
Material	A285C	A285C	A301B	A201B	A301B	A201B	A301B
Unit Stress PSI	13750	6500	13100	4500	11000	2500	7500
X-Ray	No	No	No	Yes	No	Yes	No
Stress Relieve	No	No	Yes	Yes	Yes	Yes	Yes
Joint E	80%	80%	85%	95%	85%	95%	85%
Thickness A	0.50"	0.94"	0.44"	1.38"	0.56"	2.49"	0.81"
" B	0.60"	1.17"	0.55"	1.43"	0.65"	2.59"	0.95"
Cost							
Vessel	0.54	0.63	0.66	0.85	0.70	1.47	0.83
Insulation	*0.46	**0.23	**0.23	**0.23	**0.23	**0.23	**0.23
Total	1.00	0.86	0.89	1.08	0.93	1.70	1.06

** 4" insulation outside only. Cost basis $4.00 per sq. ft.

* 4" insulation inside only. Cost basis $8.00 per sq. ft. Vessel size increased to yield same inside capacity. For extremes of insulation cost range from $3.50 to $9.50 psf the 650° vessel costs would be as follows:

$3.50 Per Sq. Ft.		$9.50 Per Sq. Ft.	
Vessel	0.54	Vessel	0.54
Insulation	0.20	Insulation	0.55
Total	0.74	Total	1.09

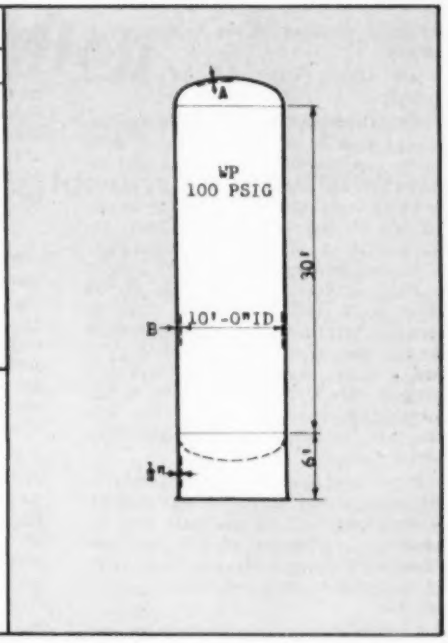

FIG. 1—Field-Erected Reactor—Data for various materials and temperatures, and cost factors relative to cost of internally-insulated vessel of mild steel (A-285-C) operating at a maximum of 650° F.

cost material has been used in each case. The API-ASME code permits the use of ASTM A-285, grade "C," at steel temperatures up to and including 900° F. Therefore, ASTM A-285-C has been used for the 650° F. temperature and also for the 900° F.

For the 950° F. and 1000° F. steel temperatures, A-201 or A-212, in either grade "A" or "B," could be used. The base cost of both steels is the same; but, inasmuch as there is no difference in allowable unit stresses at the temperatures being considered, ASTM A-201-B has been

Steel Temp. °F.	650	900		950		1000	
Material	A285C	A285C	A301B	A201B	A301B	A201B	A301B
Unit Stress PSI	13750	6500	13100	4500	11000	2500	7500
X-Ray	No	Yes	Yes	Yes	Yes	Yes	Yes
Stress Relieve	No	No	Yes	***	Yes	***	Yes
Joint E	80%	90%	95%	90%	95%	90%	95%
Thickness A	0.64"	1.00"	0.58"	1.00"	0.65"	1.35"	0.90"
B	0.64"	1.06"	0.58"	1.47"	0.65"	2.56"	0.90"
C	0.66"	1.09"	0.59"	1.52"	0.67"	2.64"	0.92"
D	0.66"	1.09"	0.59"	1.50"	0.67"	2.62"	0.92"
E	0.73"	1.23"	0.65"	1.72"	0.75"	3.00"	1.03"
Cost							
Vessel	0.70	0.97	0.92	1.12	0.95		1.12
Insulation	**0.30	*0.15	*0.15	*0.15	*0.15		*0.15
Total	1.00	1.12	1.07	1.27	1.10		1.27

All thicknesses include 1/8" corrosion allowance.

* 4" insulation outside only. Cost basis $4.00 per sq. ft.

** 4" insulation inside only. Cost basis $8.00 per sq. ft. Vessel size increased to yield same inside capacity. For extremes of insulation cost range from $3.50 to $9.50 psf the 650° vessel costs would be as follows:

$3.50 Per Sq. Ft.		$9.50 Per Sq. Ft.	
Vessel	0.70	Vessel	0.70
Insulation	0.13	Insulation	0.36
Total	0.83	Total	1.06

*** Stress Relieve in service.

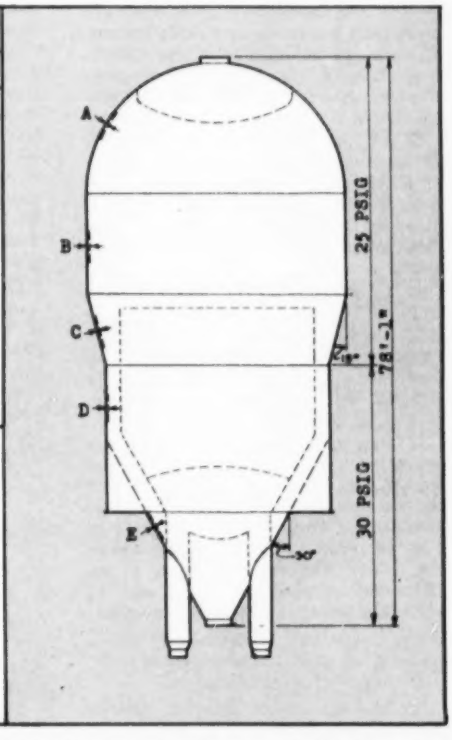

FIG. 2—Shop-Built Vessel—Data for various materials and temperatures, and cost factors relative to cost of internally-insulated vessel of mild steel (A-285-C) operating at a maximum of 650° F.

selected because of its better weldability.

All steels used are of firebox quality.

The field-erected vessel chosen for comparison is an actual reactor soon to be constructed. Its shape and dimensions are shown in Fig. 1. As it is to be built, the shell and the upper 12 in. of the supporting skirt are of ASTM A-301-B (1% chromium; ½% molybdenum; maximum carbon content, 0.12%). The balance of the skirt is of ASTM A-285-C. The internals furnished by the fabricator include the inner cone and shell, grid, and stripper cells. The cyclones and hanger rods were not included in the fabrication contract and, hence, are are not included in the estimates which follow.

For the shop-built vessel, the simple structure shown in Fig. 2 was chosen. A small amount of internals was included. A pressure of 100 psi. was considered reasonably representative of a probable range from 40 psi. to 180 psi.

Certain recognized limitations and controversial factors in such a study of vessel construction costs are recognized:

1—The cost comparsions apply only to the particular vessels under consideration. While the examples selected are reasonably typical, the results should not be extrapolated to other vessels which have materially thicker or thinner shells. Stress-relieving and X-ray requirements vary with shell thickness and could materially change the picture in other thickness ranges. Insulation quantities would vary with the shape of the vessel.

2—The cost estimates for ASTM A-301-B steel are believed to be reasonably accurate. It is pointed out, however, that this is a relatively new material with which there has been little experience in field-erected plate work.

3—It is recognized that there is wide difference of opinion on the subject of insulation of vessels in the category studied. The committee therefore specified definitely the type and amount of insulation to be included in each case.

It was concluded that the vessels operating at steel temperatures of 900° F., 950° F., and 1000° F. should be provided with 4 in. of external insulation. The insulation consists of 2 in. of magnesia and 2 in. of asbestos, which has been included at an estimated cost of $4.00 per sq. ft., including the cost of weatherproofing.

The internally lined vessel, which operates at a temperature of 650° F., is without external insulation.

On the matter of internal insulation opinion varied as to whether a simple type was to be employed, or a castable type retained by a dense castable surface layer with reinforcing mesh supported by studs from the shell. There was considerable opinion in favor of the latter type, at an estimated cost of about $8 per sq. ft. However, it was decided that probably minimum and maximum values of $3.50 and $9.50 per sq. ft. should be indicated.

Field-erected Vessels

The data for the various alternatives for the field-erected vessel are shown in Fig. 1. Some comment appears desirable. Essentially the designs are in accordance with the API-ASME code, but there are some deviations in an effort to conform with the prototype selected and with what appears to be common practice.

Perhaps the principal deviation is in the X-ray requirements. The API-ASME code would not require X-ray for ASTM A-301-B below a thickness of 1 in.; but it was the committee's feeling that, until more experience with this material has been gained, field-erected structures should be X-rayed in all thicknesses.

A word of explanation concerning stress relief will also be helpful. When a vessel is to operate at a metal temperature of not less than 900° F., there is a tendency of many owners to stress-relieve in service after the overload test. In such cases there is no overload test after stress relief, and the practice is condoned by virtue of the fact that the credit for stress relief is not taken in the joint efficiency.

Actually this practice violates the code—which requires that, when stress relief is mandatory, the overload test shall be performed after stress relief. However, the fact that it is relatively common practice to stress-relieve in service led the authors of this paper to treat the ASTM A-285 and A-201 vessels in this manner. No cost was included for field stress relief.

On the other hand, the cost of field stress relief has been included in all vessels constructed of ASTM 301-B. It is our considered opinion that stress relief should always precede the overload test on any vessel constructed of this or any other air-hardening material. In such cases it is not just a matter of relieving residual stress, but it is also a matter of heat-treating the weld metal and fusion zone so as to attain adequate ductility. In many cases there may be insufficient ductility in the "as welded" condition to permit the overload test to be passed safely. We urge caution in the continuation of the practice of stress-relieving in service when air-hardening steels are dealt with.

Cost Considerations

The cost information shown herein is relative. The cost of the internally insulated vessel which operates at a metal temperature not in excess of 650° F. has been assigned a value of $1.00. The estimate for the ASTM A-201 vessel at 1000° F. has been omitted. Its shell thickness of 3 in. places it outside practical consideration for field erection. At any rate it can be said that lack of experience in this range would render any cost estimate unreliable.

It will be observed that, in every case, the internally insulated vessel of mild steel represents the lowest cost for the field-erected reactor. The degree of cost advantage depends on the cost attributed to insulation. For those who believe that external insulation is also necessary, the cost advantage may disappear.

It should also be pointed out that the lower first cost of the internally insulated vessel may not necessarily recommend it as the best solution. The authors have already professed inability to discourse on the merits of the various alternatives, but there are certain factors which should be mentioned. There is the matter of erosion; there is also the problem of loss in efficiency which results from the deposition of carbon on the inside surface; and furthermore, there is the possibility of corrosion which is caused by condensation against the cooler shell. Useful life and possible maintenance of insulation may also be factors.

Without any attempt at evaluation of these and other factors, it is sufficient to point out that the proper choice may involve more than first cost.

Shop-built Vessels

Fig. 2 shows similar information for the shop-built vessel. In this case we have adhered strictly to the API-ASME code in all respects. In view of the foregoing discussion, it would appear that no further discussion is essential to the interpretation of the data shown.

Welding Problems

Mention is made of the problems inherent in the welding of 1% chromium, ½% molybdenum steel, such as the ASTM A-301-B in the cost tables, and it is brought out that there is no extensive experience background in the construction of vessels with this type of steel. It was found impossible to outline any definite welding procedures. Work in this field is being carried on by Chicago Bridge and Iron Co. and other agencies, and it is expected a great deal more will be known about the subject in several months.

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*"Alternate Types of Vessel Construction—A Cost Comparison," presented during the 18th Mid-Year Meeting, API Division of Refining, New York, May 11-14, 1953.

Electric Motor Lubrication

One refiner's five-year test indicates bearings with sealed lubrication have low maintenance requirements

ALTHOUGH not here yet, the time may come soon when grease cups and grease guns can be eliminated as electric motor maintenance equipment.

A five-year test with 37 motors ranging from 7.5 to 25 hp., completed recently by Atlantic Refining Co. indicated this probability. Seeking to determine whether standard, totally-enclosed "off-the-shelf" motors can operate continuously for five years on a single greasing, the company believes its test results lend considerable support in that direction.

However, the test showed that five years is too long a period for motors in that kind of service to run on the single lubrication, at least when a sizable reduction in bearing failures is required. On the other hand, continual improvements are being made in lubricants and in bearings and bearing housings, which are expected to have a hand in future progress.

Although results were not conclusive, the firm's Port Arthur refinery has now initiated a permanent program with motors through 25 hp. capacity, scheduling them for three-year lubrication intervals. From an engineering standpoint, the shorter interval seems sufficiently on the conservative side and is being recommended at present.

The hp. range selected represents a major portion of motors in use in a refinery. At Atlantic's Philadelphia refinery, 85% of the total number of 2,454 motors is in this range of capacity. This figure does not take into consideration a current plant expansion program, which should more than double the total KW demand, but no marked deviation from the percentage figure is anticipated.

The motors under test were installed on catalytic cracking units—20 at Philadelphia and 17 at Port Arthur. All were of manufacturers' standard explosion-proof construction (General Electric Co.) with class "A" insulated windings, cast-iron frames, and grease-lubricated standard Annular Bearing Engineers Committee No. 1 bearings.

For accuracy in the data, the usual drilled and tapped hole in the bearing housing for field lubrication was omitted. This eliminated the possibility of someone's removing the plug and regreasing the bearing. Bearings, of various makes, were greased at the factory with mfgrs.' standard ball-bearing grease, oxidation-inhibited. Each housing was filled about three-quarters full of grease. Motor and grease data follow:

MOTORS

Number	Hp.	Speed
9	7.5	3600
2	10	3600
12	15	3600
13	20	3600
1	25	3600

GREASE

Oil content, wt.-%	80
Acid number, mg. KOH/g. of grease	nil
Max. free alkali, KOH, %	0.3
Drop point, ° F., min.	290
S.S.U. vis. at 100° F., secs.	220 to 400
Worked consistency, mm., ASTM D217	27 to 29

Motors operated continuously except for process unit turnarounds, over a five-year period (40,000 hrs.).

Inspections were made on one motor at each refinery during each turnaround (about one-year intervals), at the manufacturer's local service shop in presence of Atlantic engineers and factory representatives.

Motors received absolutely no maintenance other than yearly cleaning of the frame, unless signs of impending failure appeared. However, dirt accumulating on the frame, in the fan enclosure, and in the ventilating slots between annual cleaning periods caused motors to operate in varying degrees of cleanliness and consequently, with different quality of ventilation. This provided means of determining the relative effect of resulting increase of operating temperature on lube and bearing life.

As a matter of fact, through a misunderstanding, motors at Port Arthur were not cleaned at all for the first three years. The end shield under the fan and some of the ventilating ducts became coated with ⅛ to ¼ in. of adhesive oily dirt, thereby reducing heat transfer from the frame.

It is significant to note that all four bearing failures or imminent failures from lube deterioration which occurred during the five-year test were on fan end bearings, and three of the four were on Port Arthur motors.

Inspection of the motors consisted in removing each end shield and noting condition of grease and bearing without removing bearings from the shaft. General checks on the winding determined whether oil had entered the stator frame. Checks were also made on whether bearings had turned in their cartridges as well as for dirt and contamination. No new grease was added except where complete replacement was necessary, and care was taken to prevent dirt entering the original grease.

If a bearing appeared rough and had to be removed from the shaft, the inner race was assumed to be disturbed and it was necessary to install a new bearing with new grease. The test of that particular motor was considered ended or beginning at that point depending on length of service.

At the completion of the five-year period, all bearings and samples of grease from each bearing were sent to the manufacturer's laboratory for detailed analysis. Motors were rehabilitated with new bearings and returned to service.

Conclusions reached by Atlantic as a result of the program, in addition to those mentioned above, were:

Both greases and bearings will need continual improvement in formulation and design to meet the rigors of five or more years of constant motor operation in refinery service, and at 3600-rpm. It is felt this improvement is definitely coming.

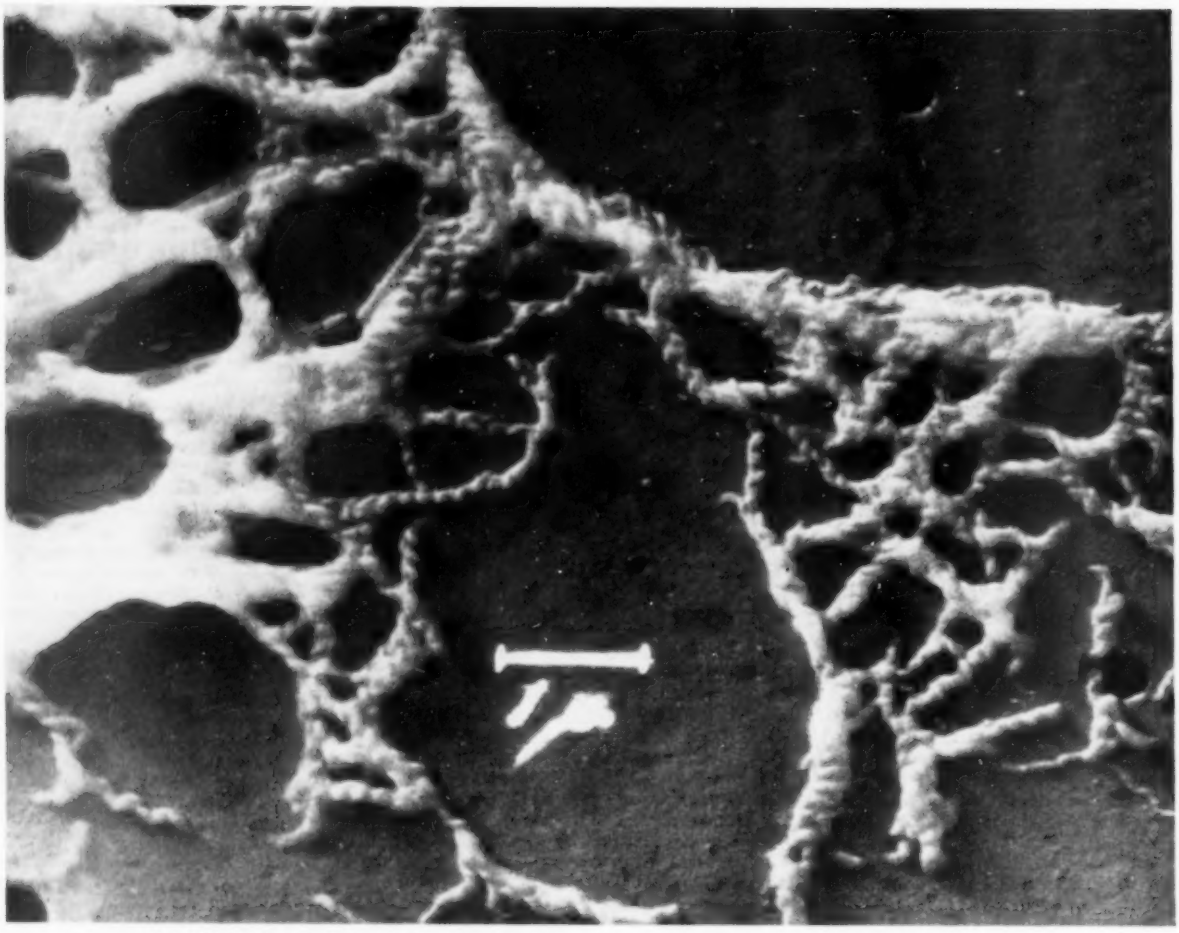
Refiners should not be satisfied until they can obtain motors which can be installed and forgotten, except for exterior cleaning. The best way to lick the problem of motor maintenance is to do all possible to eliminate it. Periodic cleaning is not difficult to regulate and is extremely important for proper operating temperature and the resulting lubricant life. Proper lubricating on the other hand, has been one of the refinery maintenance engineer's perennial problems.

Reducing maintenance by improved bearing design, better lubricants, and insulating material is made possible in no small way by use of totally enclosed frame construction. Except for a few signs of oil leakage into the stator frame, every motor involved in the test came through with windings that looked like new.

This observation lends further support to Atlantic's policy of using this type of motor exclusively in refinery service.

Acknowledgement

The foregoing material is a condensation of the paper entitled "Maintenance of Electric Motors," by Frank H. Walker, Jr., and William J. O'Meara, Atlantic Refining Co., Philadelphia, Penna., scheduled for presentation at the API Division of Refining meeting in New York, May 11-14, 1953.



MAGNIFICATIONS AT 12,000X, as in this electron micrograph of calcium soap fibers in a high-pressure grease, are just one example of . . .

Optics in Petroleum Processing

An authority reviews uses of infrared, ultraviolet, emission spectroscopy, and related optical devices

By PAUL D. FOOTE, Executive Vice President
Gulf Research & Development Co.

OPTICAL principles and equipment have become vitally important to many operations in the petroleum industry. At present, the greatest concentration of such applications is in spectroscopy—emission, infrared, ultraviolet, and the like.

Although the oil industry has not contributed materially to the development of optics, it has during the past few years utilized and adopted most of its instrumental techniques. Optics is looked upon as a tool rather than a subject for research. Just as digital computing machines have made possible outstanding developments in all fields of engineering and pure science; modern optical instruments available today are giving similar service to the oil industry.

A high school graduate, operating many of today's small, streamlined instruments, can furnish more data than a whole roomful of equipment requiring—only a few years ago—scientists at the doctorate level. The application of spectroscopy to the oil business has taken place mainly during the last decade.

Emission spectroscopy, for example, is useful in four of the major activities of an oil company—exploration, production, refining, and product development.

An important application of emission spectroscopy to refining is the examination of catalyst to determine if it meets specifications. Spectroscopic examination of samples is employed for control purposes once the catalysts are put into use. The trace elements, such as vanadium, iron, and nickel occurring in crude oil and its fractions, may build up on the surface of the catalyst and destroy its selectivity. These conditions are determined by spectrographic analysis of the powdered catalyst with

graphite in the electric arc, thus permitting control and mitigating procedures.

For product development, the emission spectrograph has countless uses. Many samples of engine deposits and sludges are examined each week. The technique provides a rapid determination of metallic or inorganic elements that may be present. Such information may indicate what materials or combination of factors are responsible for the formation of engine sludge and varnish.

Most quality lubricating oils are enriched with additives or metallo-organic compounds. Spectroscopic tests for the metallic element of the additive, such as barium or calcium, are employed for determination of the presence of the additive according to specifications, or in studies of the expenditure of the additive through prolonged use of the oil and deposition on filters.

As one of a thousand examples that might be cited in solving customer complaints, a hydraulic oil used in spinning equipment in the textile industry failed to give the desired service. Spectrographic analysis of the used oil showed the presence of copper. Copper salts are strong oxidation promoters leading to sludge formation. Investigation of the installation showed that copper was being worn from the faces of clutch plates. When these plates were replaced with other material, the trouble disappeared.

A relatively new development in emission spectroscopy, at least from the routine operational point of view, is the flame photometer that provides the emission spectra of materials in solution. The fluid, which may be either aqueous or nonacqueous, is fed at a definite rate into a controlled flame, and the spectral line intensities are measured photometrically with a high degree of precision and sensitivity. This method is useful for brines, for oils containing metallic additives, and for the direct determination of tetraethyl lead in gasoline.

Infrared spectroscopy embraces a wide field ranging from rapid routine analyses of gas samples by high-school graduates to the solution of difficult physical and chemical research problems by personnel at the doctorate level. The C_4 hydrocarbons, the butanes, butenes, and butadienes, are very important gases in certain phases of petroleum refining and the production of synthetic rubber. Previously, such mixtures were analyzed by fractional distillation.

Infrared technique reduces the time required by a factor of 1/7 and furnishes much more precise results, especially in the identification of some of the isomeric compounds. As each species in the mixture has a unique absorption spectrum, it is possible to select a group of different wavelengths, each of which is dominated by the absorption of a particular compound. The observations provide the basis whereby the experimental data are utilized in a system of linear homogeneous equations, the coefficients of which are the absorptivities of the various compounds at the different wavelengths.

These equations, forming a determinant, may be solved by ordinary algebraic methods for the concentrations of the individual gas components. However, the use of analog and digital computers is becoming routine for handling such matrices, especially in the corresponding situation presented by mass spectrograph analyses where as many as eighteen unknown vairables may be accurately delineated.

The same general procedure is used for the analysis of mixtures of liquid hydrocarbons such as gasoline. The gasoline is divided into relatively close boiling cuts, each of which may contain up to ten compounds. From the absorption spectra, the concentration of every component is determined.

Catalytic reforming, and other newer refining methods find such analyses of particular importance, because the primary aim is to effect molecular rearrangements and branched chain structures of higher octane number. With a few hours' work, each distinct molecular species in the reaction products can be recognized by its absorption spectrum. Positive identification by chemical means involves time-consuming fractional separations, boiling or melting point determinations, refractive indices, and other procedures.

The American Petroleum Institute's catalog of standard spectra prepared and maintained under the direction of Dr. Frederick D. Rossini, originally at the National Bureau of Standards and now at Carnegie Institute of Technology, serves as the library of information for this type of analytical investigation.

A particular atomic grouping may be responsible for a certain portion of the infrared spectrum of the molecule in which it occurs. Such a condition permits the determination of group types. For example, the carbonyl group provides absorption in the 5.5-6 μ region for all molecules in which it occurs.

Analysis by class of compounds is often desirable in petroleum chemistry, as, for example, the determination of the olefins present in a gasoline. There are five different types of aliphatic mono-olefins, each of which possesses a characteristic absorption band, whereas by purely chemical means differentiation is impossible.

The fact that definite atomic groupings possess absorption frequencies that are approximately independent of the remainder of the molecule provides a powerful tool for the determination of molecular structure. The spectroscopist obtains the infrared spectrum and then proceeds

Meet the Author

Paul D. Foote is executive vice president and director of research of Gulf Research & Development Co. and vice president of Gulf Oil Corp. and Gulf Refining Co.

He received an A.B. from Western Reserve University, M. A. from Nebraska, and Ph. D. from Minnesota. Dr. Foote then joined the National Bureau of Standards as a physicist. During some 16 years service, he did pioneering work in optical design and instrumentation.

In 1927, he was appointed senior fellow of the Gulf Fellowship at Mellon Institute and during the next two years organized a coordinated program for research in petroleum production and transportation for Gulf. When the research company was incorporated in 1933, Dr. Foote became executive vice president and research director.

He organized and for many years edited the *Review of Scientific Instruments* and was also editor-in-chief of the *Journal of the Optical Society of America.* He is a past president of the American Physical Society and past secretary of the Optical Society of America. He is author or co-author of several technical books and about 150 articles in the fields of radiation, atomic structure, pyrometry, and petroleum technology.

Dr. Foote is an officer of the National Research Council, and member of many scientific and technical societies, as well as service organizations in Pittsburgh, where he makes his home.

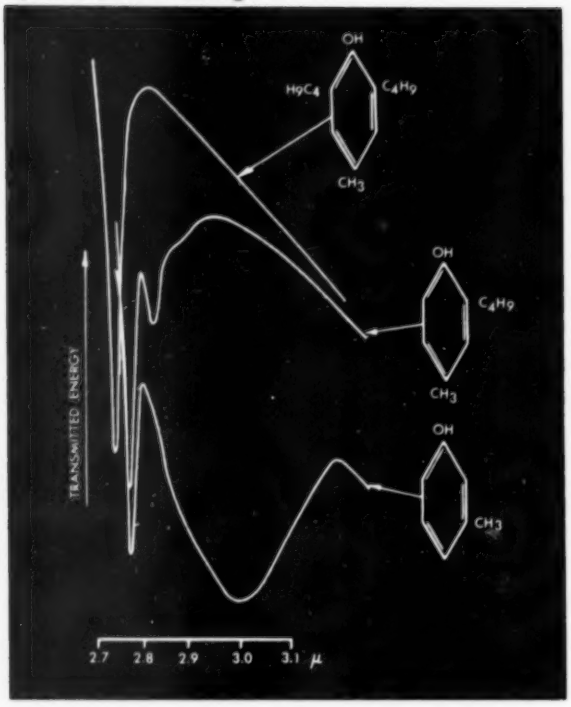


FIG. 1—Infrared absorption spectra in the hydroxyl region for phenols of three classes

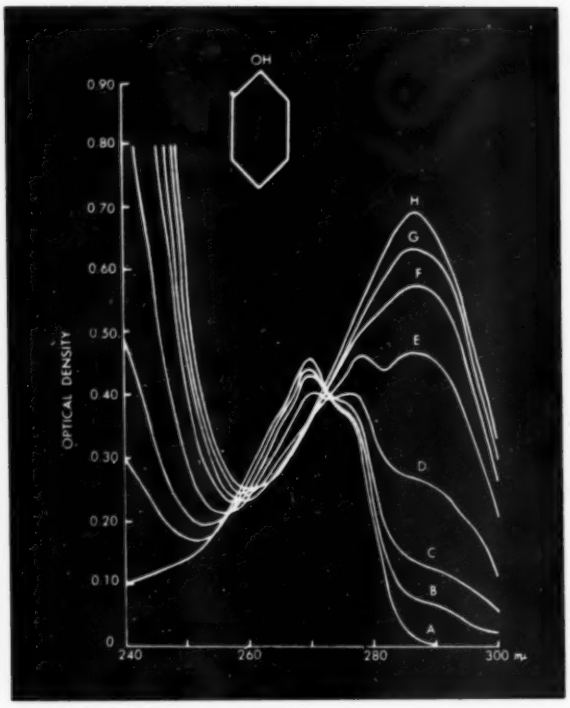


FIG. 2—Ultraviolet absorption spectra of a constant concentration of phenol under different ionization conditions

to interpret it in terms of known atomic groupings. When this information is correlated with the chemistry of the material, it is often sufficient to establish its structure. Such work is a tool for the chemists in their syntheses of new petroleum additives and chemical compounds.

Chemical research finds infrared spectroscopy playing a fundamental role. For example, we have found that some phenols substituted with large alkyl groups in both positions *ortho* to the hydroxyl group were oxidation inhibitors of exceptional potency. However, phenols of this class were quite anomalous in their properties, compared to simpler phenols, and there was even the question as to whether they were actually phenols or perhaps ethers. (Fig 1).

The lower curve in the chart is for an unhindered phenol. Note that two bands are present. The one on the left is due to the free or nonbonded hydroxyl group; and the strong broad one on the right is due to hydroxyls which are members of strong intermolecular hydrogen bonds.

The middle curve is for a partially hindered phenol. It also possesses two bands, the one on the left due to the free or nonbonded hydroxyls and the weak one on the right due to hydrogen-bonded hydroxyls. The latter is weak and only slightly shifted to longer wavelengths as the *t*-butyl group on the *ortho*-position effectively hinders strong hydrogen bonding.

The upper curve is for a hindered phenol. Note that it displays only the absorption of free or nonbonded hydroxyls. The two *ortho*-substituted *t*-butyl groups sterically hinder the forming of even weak hydrogen bonds. The concentration in each case is approximately 0.7 mole/liter.

From absorption studies of a broad class of phenols and data on the absorption of the hydroxyl group, it was shown that the large alkyl substituents on the *ortho*-positions sterically hinder the reactions and effects normally exhibited by hydroxyl groups. Thus there was provided a sound explanation of the anomalous properties of these phenols and also valuable information relative to the interactions of polar molecules.

Organic compounds displaying ultraviolet absorption generally possess a relatively high degree of unsaturation. The others are transparent to this region of wavelengths.

This is an ideal situation for petroleum technology. Aromatic materials are highly unsaturated and constitute an important class of useful hydrocarbons. Their determination by ultraviolet absorption methods has been of great aid to petroleum processing. For example, the power available for take-off of an airplane with a reciprocating engine depends to a large extent upon the concentration of aromatics in the gasoline.

Gasolines and similar petroleum fractions are now routinely analyzed for the lighter aromatics through the xylenes by ultraviolet absorption. These comprise benzene, toluene, ethylbenzene, and the isomeric xylenes. Each possesses a characteristic absorption spectrum, and characteristic frequencies may be chosen for each by the method already described for the infrared analysis of gas mixtures. The procedure is quite simple: The gasoline is cut into several fractions, each of which may contain several aromatics. These fractions may then be analyzed by a high school graduate with an expenditure of less than one hour per sample.

In the higher boiling ranges, the number of aromatic compounds increases rapidly, and the spectra are too similar to allow analyses for individual species. However, it has been found that certain classes possess such similar spectra that analyses may be made for total concentrations by classes. Thus, for boiling ranges above the xylenes, a fraction may be analyzed for the mono-substitued aromatics as a class, the *ortho* and *meta* di-substituted aromatics as a class, and for various sub-classes of *para*-substituted aromatics.

Today the plastics industry obtains much of its raw materials from petroleum refineries. Important among these are benzene, *para*-xylene, and styrene, the latter being the basic in-

gredient of polystyrene. The plastics industries require these materials in high purity, and ultraviolet spectroscopy is widely used for control analyses and purity assay. These operations can be performed very rapidly in contrast to alternative chemical tests.

An interesting extension of ultraviolet absorption analyses for aromatics is the determination of phenols in gasolines. These occur in relatively small concentrations, and their absorption is entirely masked by the absorption of the aromatics. However, it is important in studies of storage stability of gasolines to determine the phenol content accurately. In this case, advantage is taken of their ionization and solubility, in ionic form, in an aqueous alkaline phase. (Fig. 2)

The letters on the chart refer to the amount of NaOH in the solvent as: *A*—pure water; *B*—5×10^{-5} mole/liter of NaOH; *C*—1×10^{-4} mole/liter of NaOH; *D*—2×10^{-4} mole/liter of NaOH; *E*—4×10^{-4} mole/liter of NaOH; *F*—6×10^{-4} mole/liter of NaOH; *G*—8×10^{-4} mole/liter of NaOH; *H*—1×10^{-3} mole/liter of NaOH.

Curve *A* is the spectrum of un-ionized phenol, whereas curve *H* is the spectrum of the phenolate ion. The other curves are for solutions containing both the un-ionized and the ionized forms.

The gasolines are washed with an alkaline solution which is then examined for its ultraviolet absorption due to the extracted phenols in ionic form. Such an analysis may be made quite rapidly and detects very small amounts of phenols.

Another example of the selectivity for ultraviolet absorption because of unsaturation is in the analysis for the diolefin, butadiene. Because of its high degree of unsaturation, it is the only species of its molecular weight range that possesses ultraviolet absorption. Furthermore, its absorption is very strong. This allows gas streams or mixtures to be accurately analyzed for butadiene in a short time. In addition, it permits mixtures to be analyzed for extremely small concentrations of butadiene. As a result, ultraviolet absorption has been of great value in that segment of the petroleum industry concerned with the production of synthetic rubber.

Although not as powerful as infrared spectroscopy for the purpose, ultraviolet examinations play an important role in the determination of molecular structure, particularly when applied in conjunction with the former. As a relatively high degree of unsaturation is generally required for a molecule to possess ultraviolet absorption, the presence of the latter immediately classifies the material with regard to its unsaturation. A product of unknown structure as synthesized or as extracted from a crude or petroleum fraction may be examined for its ultraviolet spectrum, and immediate information is available regarding the presence of such structural groups as a benzene ring, a naphthalene structure, conjugated diolefin groups, etc.

An example of a research application of ultraviolet absorption may be found in the study of the ionization behavior of certain water soluble materials such as the phenols. Because of the electrostatic interaction of an ion with its environment, the ultraviolet spectrum of the ionized form of a material is shifted in wavelength from that of the un-ionized material. In both cases the concentrations may be directly inferred from the intensities of absorption. This information plus the independently obtained pH of the solution may then be used to calcualte the dissociation constant for the material.

Raman spectroscopy has not been used extensively in the petroleum industry because of experimental difficulties. However, with the major improvements now in the process of development, such as a photomultiplier detection system for the direct measurement of spectral intensities, there is little doubt that this powerful tool will become an important analytical adjunct.

Raman spectroscopy has been used in some petroleum laboratories to analyze for aromatics and olefins. In certain molecules, there are important vibrational frequencies that are inactive to infrared radiation but which can be excited by the Raman technique. The method offers a valuable complement to infrared absorption for the determination of molecular structure and for special analytical problems. Among the latter are systems involving aqueous solutions that can not be handled by work in the infrared.

Automatic sampling and control systems are a development in optics that started during the war, and have grown very rapidly since, mainly taking the form of using automatic optical instruments to analyze a process stream for a particular component. The analysis information is continuously recorded with a standard recorder, or it may be used to control automatically the process yielding the stream being analyzed.

The most important among such instruments is the infrared gas analyzer. This device utilizes infrared absorption effects as described earlier. However, it does not achieve a spectral decomposition of the light beams as is done in a spectrometer. Rather, it uses a filter principle, and in simplest terms it may be said to achieve an analysis for a particular component by comparing the absorption exhibited by the sample gas with the absorption of a standard reference gas. The unbalance in absorption is detected electrically, amplified, and fed into a recorder or an automatic controller.

These devices have been engineered so that the optical sensing element may be located in the refinery adjacent to the processing equipment while the recorder may be some distance away in the instrument and control room.

These analyzers are very important to systems where the concentration of a single component is a criterion of performance for a particular process unit. An example occurs in the production of high octane gasoline by alkylation. In this process, isobutane is reacted with butylenes to give the high octane gasoline called alkylate. The latter is then stripped by fractional distillation of first the C_3 and lighter components in a depropanizer, and then of the butanes in a debutanizer. The gas from this unit comprises a mixture of iso- and normal butane which is then separated in a de-isobutanizer.

This separation is important as there is a large difference in the value of these two gases. The butane is of use only for fuel gas or to raise the vapor pressure requirements of gasoline whereas the isobutane is valuable to fed back to the reactor as a component for the further production of high octane gasoline.

If the de-isobutanizer tower is functioning poorly, a considerable amount of money may be lost if the isobutane passes into the normal butane stream. However, an infrared gas analyzer can be used on the stream to measure continuously the isobutane concentration. If it goes too high, the operating characteristics of the tower may be changed either by automatic control equipment or by an operator to regain the separation efficiency.

Another example of application of such devices is in the analysis of flue gases from catalytic cracking units. After catalyst is used for a time in a cracking operation, it loses its activity because of the deposition of coke. It is regenerated by burning off the deposited carbon, and the gaseous discharge from this reactivation process is called flue gas. A continuous knowledge of the carbon dioxide and carbon monoxide concentration in the flue gas is useful in determining the amount of carbon removed by burning and in estimating the residual carbon deposit. The infrared gas analyzers are particularly desirable for such continuous analyses.

Instruments of similar basic prin-

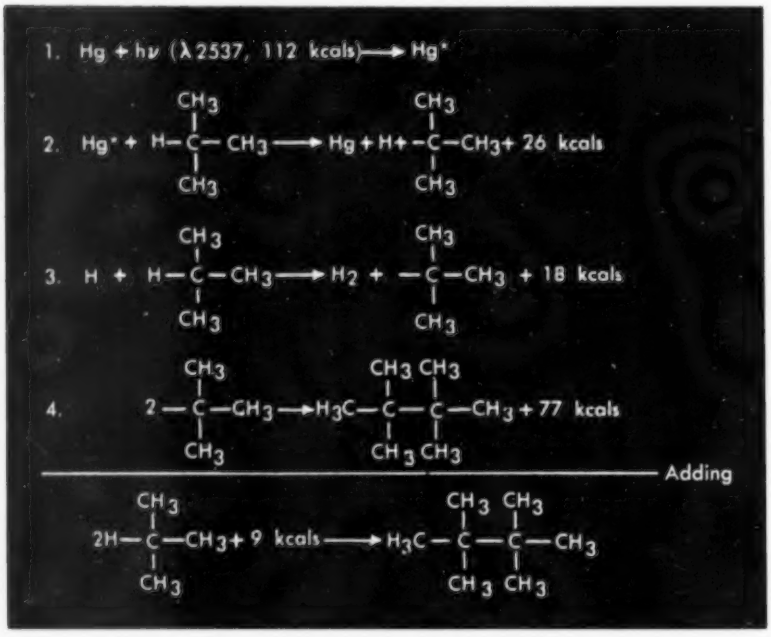

1. Hg + hν (λ2537, 112 kcals) → Hg*
2. Hg* + H–C(CH3)2–CH3 → Hg + H + –C(CH3)2–CH3 + 26 kcals
3. H + H–C(CH3)2–CH3 → H2 + –C(CH3)2–CH3 + 18 kcals
4. 2–C(CH3)2–CH3 → H3C–C(CH3)2–C(CH3)2–CH3 + 77 kcals
Adding
2H–C(CH3)2–CH3 + 9 kcals → H3C–C(CH3)2–C(CH3)2–CH3

FIG. 3—Formation of 2,2,3,3, tetramethyl butane

ciples but utilizing ultraviolet radiation have also been successfully employed with streams where the concentrations of highly unsaturated materials such as aromatics and butadiene are critical.

The general progress in optics in recent years is making possible the development of other types of instrument for automatic analysis and control.

An example is a recently reported automatic refractometer which gives reliable indications of changes of index of refraction as low as 0.0001 unit or less. Furthermore, this device is so engineered as to allow its use in outdoor process plant locations. One application has been the automatic control of a distillation column separating hexanes.

A most fundamental and important application of optics is in the calculation of thermodynamic functions from spectroscopic data.

Some years ago, when this work was undertaken by Rossini and Pitzer as American Petroleum Institute Project 44, practically no accurate thermodynamic data were available for the hydrocarbons as compared with inorganic compounds.

Today, this situation is completely reversed, and unquestionably the most up-to-date and extensive data are those for the hydrocarbons. Free energies of formation, heat capacities, and enthalpies as functions of temperature are presently available for more than 210 hydrocarbons including paraffins, olefins, diolefins, acetylenes, naphthenes, and aromatics, in most cases to 1500°K.

These data have proved of inestimable value in research and engineering development on numerous petroleum processes such as isomerization, alkylation, polymerization, hydrogenation, dehydrogenation, aromatization, etc. Today, research on a new process for converting one class of hydrocarbons into a more desirable class of hydrocarbon products is seldom undertaken in the petroleum research laboratory until a preliminary study, however cursory, is made of the pertinent thermodynamic data.

It is to be hoped that, with the emergence of the petroleum industry into the attractive field of petrochemicals, the invaluable thermodynamic data on the principal types of hydrocarbon derivatives will become available. Much of this information will be provided by the statistical method of calculation based on spectroscopic data.

Another valuable, though less elegant, application of optics has been the widespread use of accelerated stability tests in which petroleum fractions such as fuel oils or lubricating oils are irradiated with visible or long wavelength ultraviolet light in the presence or absence of air or oxygen.

Such tests are not included in the standard A.S.T.M. tests on petroleum products but have been used from time to time as valuable research tools. Instability of the product under test is usually indicated by the formation of high molecular weight resinous deposits resulting from condensation and oxidation reactions.

Strong visible or near ultraviolet light absorption, as indicated by color, is a rather rare phenomenon among the hydrocarbons. It is limited almost entirely to compounds containing conjugated double bonds, i.e., alternating single and double carbon-carbon bonds.

Characteristic examples of organic compounds with conjugated double bonds include the following principal types: aliphatic, such as $C_{40}H_{56}$, lycopene; cyclic non-aromatics, such as $C_{10}H_8$, azulene, C_8H_8, cyclooctatetraene, and C_8H_{10}, dimethylfulvene; and aromatics, such as $C_{18}H_{12}$, naphthacene, and $C_{22}H_{14}$, pentacene.

Besides showing strong light absorption, these conjugated hydrocarbons have long been recognized by the chemists as particularly reactive materials. They are known to have a marked affinity for so-called electrophilic reagents like hydrogen ions and other atoms, ions, or compounds like oxygen, halogens, and aluminum halides which are electron deficient. They are especially susceptible to oxidation and, in accelerated light stability tests, are probably responsible not only for the initial light absorption but also for much of the ensuing over-all chemical degradation.

Recently these conjugated hydrocarbon systems have attracted considerable attention from spectroscopists. It has been shown by several investigators that a simple model, in which the π-electrons of the double bonds are considered as an electron gas in a one-dimensional space corresponding approximately to the length of the molecule, can satisfactorily explain the frequencies and intensities of absorption of linear conjugated hydrocarbons. Such a model is in accord with well-established ideas of the chemists regarding the resonance or oscillating character of the double bonds in conjugated systems. It is also, in effect, the Sommerfeld model of a one-dimensional metal and is closely related to modern theories of the structure of semiconductors. It is entirely possible that further study of the optical and electrical properties of these simple hydrocarbons will shed light on some of the more complex, three-dimensional problems of solid state physics.

Photochemistry in refining and petrochemical processing is a possibility for the future of this field as advances are made in optical engineering. For example:

Isobutane C_4H_{10} and isobutene C_4H_8 in the presence of acidic catalysts combine to form isooctane C_8H_{18}. This process, known as alkylation, is

responsible for the production of high octane aviation gasoline. If, instead of forming 2,4,4-trimethyl pentane, we could form an octane of completely branched structure, 2,2,3,3-tetramethyl butane, the research octane blending value would be 130 instead of 100 for ordinary isooctane, but no catalyst is known through which such a reaction can take place.

However, it can be produced by mercury-sensitized photolysis of isobutane. Isobutane with a micron or so of mercury vapor is illuminated with λ 2537. The excited mercury atoms collide with isobutane molecules transferring energy that results in scission of the tertiary carbon-hydrogen bond that is about 1-2 kilocalories weaker than the other nine primary carbon-hydrogen bonds of the isobutane molcule.

A tertiary butyl radical and a hydrogen atom are formed, and the mercury atom returns to the normal state. The hydrogen atom reacts with a second isobutane molecule, proucing a hydrogen molecule and another tertiary butyl radical. Combination of the butyl radicals results in the desired branched structure. The reaction scheme is shown in Fig. 3 with the approximate energy quantities involved.

Although the over-all reaction is endothermic to the extent of only about 9 kcal, in order to break the carbon-hydrogen bond 86 kcal are required. Utilization of λ 2537 quanta for this purpose is very efficient, and the quantum yield approaches unity. If we had more efficient sources of ultraviolet light, such a laboratory synthesis might be commercialized. Photochemical reactions of this type may eventually play a role in petroleum refining and the petrochemical industry as optical engineering advances.

Refractive index represents another optical property useful to the petroleum industry. Certain compounds occurring in petroleum rotate the plane of polarized light usually to the right but in a few instances to the left. Organic compounds showing optical activity are known to arise only through the agency of living organisms, thus affording evidence against any theory of the inorganic origin of petroleum. At least one of these optically active compounds has been isolated with a composition approximating $C_{25}H_{52}$. While its structure has not been determined, it is evidently highly naphthenic, possessing three to five condensed rings.

In addition to their use in the routine control of laboratory operations, refractive index and refractive dispersion are most important properties for the study of the composition and constitution of hydrocarbon systems. Combined with other easily measured physical properties, such optical data permit evaluation of the proportion of paraffinic, naphthenic, and aromatic groups present in any petroleum fraction. The Lorentz-Lorenz specific refraction formula is an additive relationship that allows for the calculation of molar refractions for individual molecules and molecular groupings.

Finally, several research and test methods should be mentioned at least by name, such as fluorescence, phosphorescence, thermoluminescence, and colorimetric analysis. With the latter technique, aliquot parts of a prepared solution containing some metal are treated with a color-forming reagent, usually organic in nature, and the characteristics of the color as measured with a spectrophotometer or colorimeter are a known function of the concentration of the metal being analyzed.

X-ray fluorescence and absorption spectroscopy are finding an ever-increasing number of applications as nondestructive analytical tools. X-ray diffraction provides a means for determining structural changes, both reversible and irreversible, that occur with catalysts following heat treatment, chemical transformations, and other changes affecting catalytic activity. X-ray absorption is employed for the determination of sulfur in hydrocarbons, and lead in gasoline. We also determine the fluid distribution in rock samples by x-ray absorption in connection with investigations of the flow of liquids and gases through porous media.

In chemical synthesis, it is necessary to know the molecular structure of the products in their various stages of formation. For example, important compounds might be formed from $C_4H_4S_2$ and accordingly the structure of this material has been recently determined by our laboratory. This is a projected graph of electron densities in the unit cell. Plots of this type are obtained by mathematical computation using the intensities and phases of x-rays scattered from the atoms in the unit cell that functions as a three-dimensional diffraction grating.

Electron diffraction techniques provide rapid and reliable information on the detailed structure of a surface film, for example, films resulting from corrosion or from an oil quenching bath. Neutrons may also be diffracted by crystalline structures in much the same way as electrons and x-rays. Hydrogen atoms may be thereby directly located in crystal structure although recent advanced techniques are beginning to show positive results on hydrogen with x-ray analysis.

The mass spectrometer, while perhaps not an optical instrument, has much in common with optical techniques as applied to gas analysis. Many gas samples requiring four to six hours to analyze by fractional distillation may be completely analyzed by the mass spectrometer in less than 1¼ operator hours. Of this time only a period of 15 minutes is instrument time.

This means that one instrument can process several hundred gas samples per week, and its use may be extended to liquid mixtures involving as many as 18 unknown variables. For such complicated routine procedure, the signals obtained from the instrument may be automatically converted into digital form and fed into a digital computing machine that prints the analyses on tape or cards. Such installations are costly but provide information that either could not be secured with desk calculators or would be impractical on account of the operating expense.

Microwave Spectroscopy is perhaps the one final optical technique to call attention to. Without exhaustive investigation, it appears that the first reported work was in 1934 by C. E. Cleeton and N. H. Williams using 1.13-cm wavelength, a collimating system of parabolic mirrors, and an echelette grating to measure wavelengths.

Perhaps absorption spectra in this region are not too far removed from the intrared to fall into the same general category. At any rate progress in this field, including work with hydrocarbon derivatives, is so substantial that it may soon be adopted by the petroleum laboratory as an additional tool for the chemists, and possibly for certain process controls. It is worthy of note that because of controlled source and tuned detectors the microwave spectroscope has exceptional sensitivity and resolving power. Its resolving power is on the order of 100,000 times that of the best infrared grating spectrometer. But, of course, the microwave and optical methods are complementary, not competitive, devices.

This concludes an exhausting, but far from exhaustive, survey of the use of optics in the petroleum industry. Our industry is appreciative of the work of the scientists who have devoted their lives to optical research, and of the fact that we have a progressive optical instrument industry that makes the scientists' work readily available to the industrial laboratories. Finally, I desire to thank my many colleagues who have assisted me in the preparation of this report, especially Mr. Norman D. Coggeshall, Mr. C. W. Montgomery, and Mr. Ralph D. Wyckoff.

The preceding article is based upon a paper, "Optics in the Oil Industry," presented by Dr. Foote at the 1952 Conference on Optical Methods in Industry, University of Rochester, and later published in the *Journal of the Optical Society of America*.

Clad Steel in Petroleum Equipment

Six "borderline" cases of when to use as well as when not to use this material in processing units

By ALBERT HOERSCH, Jr.
Lukens Steel Co.

CLAD steels are a useful family of materials whose properties are well-known to designers, fabricators, and operators of petroleum and petrochemical processing equipment. Whole books could quite properly be devoted to the subject.

However, clad steels are not a "cure-all," and for some applications, carbon steels are a better choice. In every instance, the choice of a material depends basically upon the economic factors involved. Decisions arrived at in border-line cases, and the reasoning behind those decisions, are believed to be of greater interest than descriptions of process units constructed according to general practice and "to the book."

The following six examples of equipment material selection are such border-line cases—where a multiple choice confronted the engineer. Taken from the notebooks of refinery engineers, they are of interest not so much for the engineering and cost factors involved as for the line of approach that should be followed in determining specifications.

Both general categories of corrosion are included in these examples: high temperature (usually above 500° F.) and low temperature corrosion. High temperature corrosion, where water is absent, involves attack from such agents as sulfur, naphthenic acids liberated from the crude oil, solvents like phenol and furfural, chlorine, and oxidation outside the equipment. Below 500° F., water is generally present, and electrolytic corrosion must be combatted.

1—Caustic Regenerator

A caustic soda regenerator, operating at 255° F. bottom temperature, was used to strip mercaptans from a 10% solution of sodium hydroxide. The column was lined originally with 6-in. wide Monel strip linings. After a period of operation, leaks in the strip linings caused excessive corrosion to the carbon steel backing, due to electrolytic action. The carbon steel column corroded at about 60 mils/yr., with somewhat higher corrosion rates where steam was injected into the stripping column. Interruptions in the column's operations resulted in erratic treating operations and the consumption of excessive quantities of new sodium hydroxide.

Repairs to the strip lining were impossible to make, due to contamination of the Monel surface with sulfide deposits. These deposits caused excessive cracking of the strips when corrective welding was attempted, and it proved impossible to remove the sulfide satisfactorily from the Monel surface.

Based on an evaluation of corrosion rates of various materials, the cost of emergency down time and the anticipated long future use of this equipment, it was decided to replace the column with a shell fabricated of 10% nickel-clad steel, equipped with trays and nozzles of solid Monel.

The new column has been in service since the latter part of 1950. It has required no maintenance due to corrosion, and emergency shutdowns have been completely eliminated.

2—Cracking Vessel

A cracking vessel, handling hot naphthenic-base crudes with about 1% sulfur content, operated at approximately 800°F. Built of carbon steel, this column corroded at a rate of 37 mils/yr., and after some years of operation it became necessary to replace it.

The cost of a carbon steel column at this time, fabricated of 1-in. carbon steel, was estimated at $0.25—0.275/lb., and from $11 to $12/sq. ft.

The cost of an equivalent 7/8-in. column, fabricated of 20%, Type 405, stainless-clad steel, was estimated at $20/sq. ft. over the cost of carbon steel construction.

Stainless-clad plate was selected for the replacement column, based on anticipated long-term application for the equipment and the existence of a tight refinery production schedule that made unscheduled maintenance shut-downs of the equipment extremely costly.

The stainless-clad column has been in operation since 1947, and although minor repairs have been made to the internals and to one nozzle, otherwise uninterrupted service (except for scheduled shut-downs) has been maintained.

3—Acid Sludge Process

In one refinery, some small 1,000-bbl., open-top, acid-sludge-processing tanks were originally constructed of lead-lined steel. Cost of these lead-lined steel tanks was approximately $13,000 apiece, compared to $5,000 for a similar unlined tank of carbon steel.

Considerable difficulty was experienced in maintaining lead linings sufficiently leak-free to permit operation of the process. Continued operation of the process was essential to dispose of the sulfuric acid sludges produced in the treatment of lubricating and sludge oil.

A study of the process involving the neutralization and treatment of these sludges suggested a modification which made it possible to eliminate the lead lining. Severe pitting and general corrosive attack, however, would occur on the lower two ft. of the shell, and on the flat bottom plates of the tank. The lower two ft. of the shell was fabricated from Type 316 ELC, stainless-clad steel; the flat bottom from solid Type 316 ELC, since welding could be done only on one side of the plates. Welding was done with 25-20 electrodes, and Type 316 ELC backing strips were used in welding the flat bottom.

In this case, clad steel was selected in preference to strip linings for the following reason. The location of possible leaks that develop in a clad steel or solid alloy steel tank section can be quickly pin-pointed and repairs completed in a minimum of time. With strip linings, finding

Meet the Author

Albert Hoersch, Jr., technical service engineer with Lukens Steel Co., Coatesville, Penna., was graduated in 1938 from the University of Pennsylvania with a chemical engineering degree. Since then he has had 15 years of engineering experience in industry and the government. He was in research for a refining company until 1941; then spent two years with a compressed gas organization; and nine years with the U. S. before joining Lukens in 1952.

Mr. Hoersch is a member of the American Chemical Society and of Alpha Chi Sigma.

the leaks may take several days. This potential delay was unacceptable for this particular installation.

When the tanks were inspected after a period of service, an interesting point was brought out.

It is most important when working with low-carbon alloy or clad steels to avoid carbon pickup in welding operations, otherwise carbon content of the material may be disastrously increased. Carbon steel fit-up clips were used on this particular job without the knowledge of the supervising engineers. After the plates were welded, these clips were chipped off, and the surfaces ground smooth.

It was found, however, that pitting due to contamination had occurred wherever these clips had been welded to the stainless plates. It was necessary to chip and grind these spots, fill the pits with 25-20 weld metal, and grind them smooth once more.

The moral is that all sources of surface contamination, such as grease, oily waste, dirt and carbon steel erection clips should be carefully guarded against in fabricating corrosion-resistant alloy steels.

4—Vacuum Column

A vacuum column vapor inlet had a velocity of 2,400 to 5,000 fps. This 21-ft. inside diameter column handled naphthenic-bearing stock with fairly low sulfur content. Erosion was a serious problem, and a number of different types of wear plates, including clad steels, were experimented with in an effort to reduce this attack. These wear plates were placed along the periphery of the nozzle inlet. Clad steel wear plates, in this case, eroded more rapidly than carbon steel plates.

Carbon steel wear plates, varying from ¾ in. to ½ in. in thickness were finally selected in preference to clad steels. The inlet nozzles, incidentally, were coated with a hard-faced alloy, which has proved to be a very satisfactory protection in this installation.

5—Horizontal Settlers

In one case, where spent acid storage tanks and horizontal settlers handled diluted sulfuric acid of 65-70% effective acidity, the best indicated corrosion-resistant material was Monel-clad steel. Carbon steel corroded out at a rate of 60 to 80 mils/yr. Examination of various materials showed Monel-clad steel or aluminum bronze would corrode at a minimum rate, and would be very suitable for the process.

The anticipated high obsolescence rate of the equipment, however, and the comparatively high initial cost of Monel-clad steel for such short-term service, determined that the vessels should be fabricated of plain carbon steel, with a corrosion allowance compatible with anticipated obsolescence.

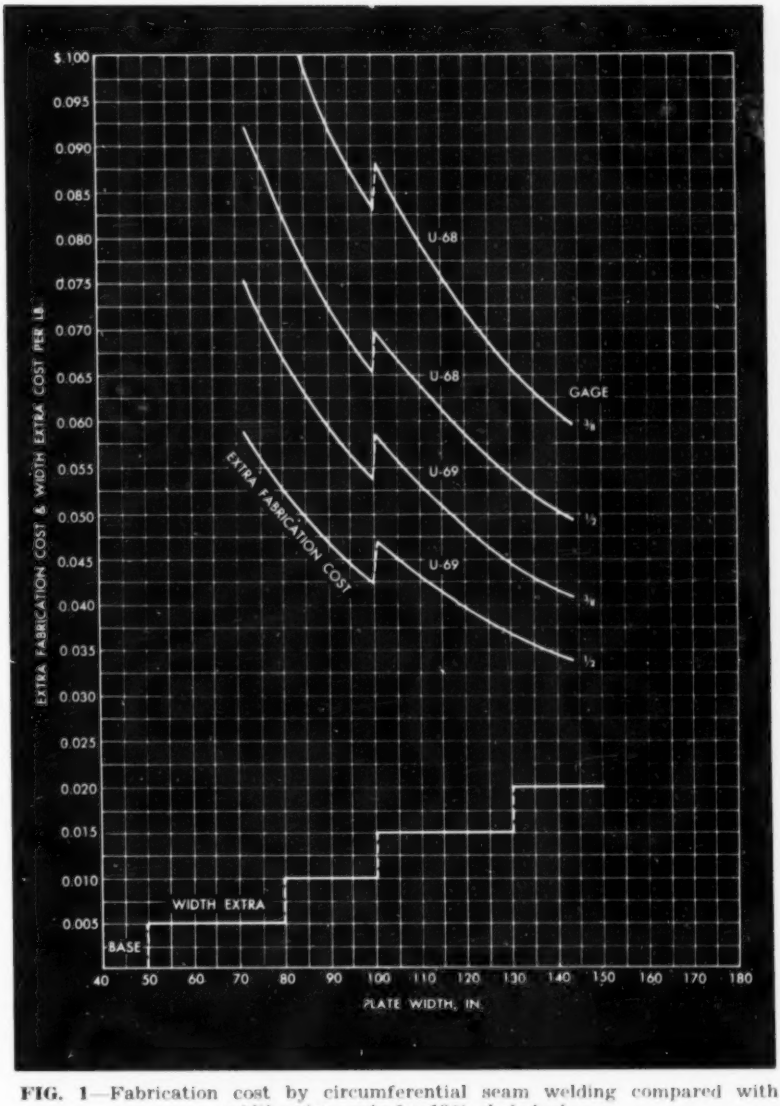


FIG. 1—Fabrication cost by circumferential seam welding compared with width extra costs for 10% clad steel

6—Crude Fractionator

A crude fractionator overhead condenser and accumulator handled an overhead product containing appreciable quantities of water. H_2S, HCl and organic acids. The condenser shell and accumulator were rapidly attacked.

An evaluation of ways in which this corrosion could be reduced developed the following proposed methods, which were carefully studied: (a) improved de-salting of the crude, (b) ammonia neutralization, and (c) water washing of the overhead streams.

It was determined that the most economical solution was to provide a corrosion-resistant lining in the heat exchanger and accumulator. Strip-lining of these vessels was considered and, particularly in the case of the condenser shells, was discarded for the following reasons:

Strip-lining had the disadvantage of irregular interval service, making fit-up difficult, and would require redesign of the condenser elements to permit their insertion inside the lining. Monel-clad steel condenser shells overcame these objections, and new shells were fabricated to an inside diameter permitting use of the existing tubular elements, which were in good condition.

An evaluation of the economics of strip lining repairs versus alloy-clad steel indicated a distinct advantage to the shop fabrication of a new Monel-clad accumulator vessel, and the old vessel was accordingly replaced.

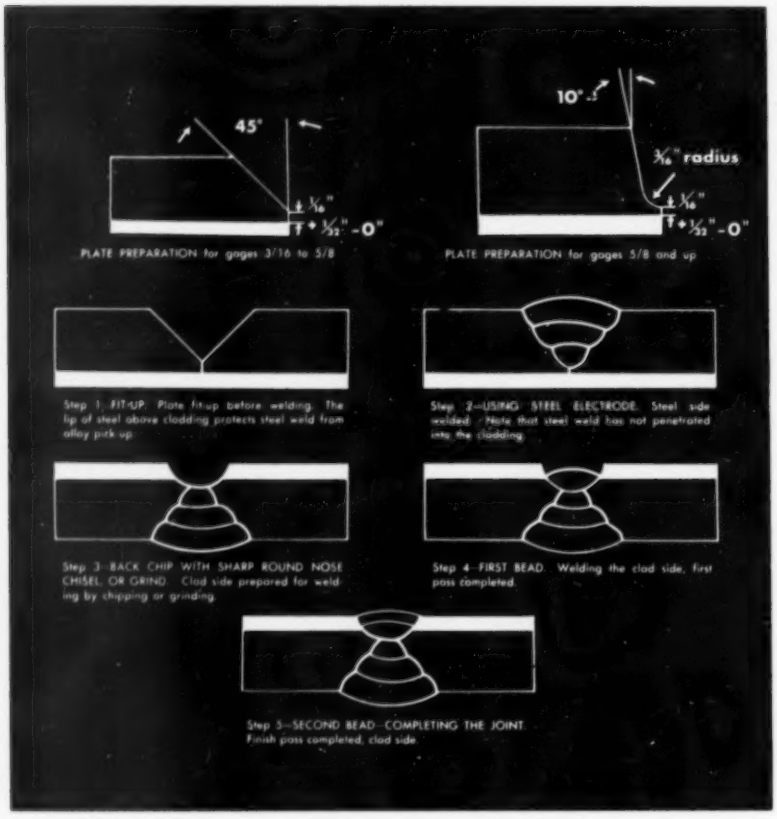

45°
± 1/16"
+ 1/32" -0"
PLATE PREPARATION for gages 3/16 to 5/8
10°
3/16" radius
± 1/16"
+ 1/32" -0"
PLATE PREPARATION for gages 5/8 and up
Step 1—FIT-UP. Plate fit-up before welding. The lip of steel above cladding protects steel weld from alloy pick-up.
Step 2—USING STEEL ELECTRODE. Steel side welded. Note that steel weld has not penetrated into the cladding.
Step 3—BACK CHIP WITH SHARP ROUND NOSE CHISEL OR GRIND. Clad side prepared for welding by chipping or grinding.
Step 4—FIRST BEAD. Welding the clad side, first pass completed.
Step 5—SECOND BEAD—COMPLETING THE JOINT. Finish pass completed, clad side.

FIG. 2—The steel side is welded first in fabrication with clad plate

40°
± 1/16"
PLATE PREPARATION for gages up to 3/8
PLATE FIT-UP before welding. Allow 3/32 in. root gap to permit full penetration of alloy electrode.
STEEL SIDE WELDED. Note root pass penetrated through cladding, thus eliminating need for back-chipping on clad side.
CLAD SIDE WELDED with single pass after cleaning with power-driven rotary stainless steel wire brush.

FIG. 3—Full alloy welds; recommended for light-gage and small diameter vessels, not subject to cyclic or high-temperature operation

In most shops, unless specifically equipped to put in strip linings with automatic welding machines, it is more economical to fabricate vessels from clad steels. Strips used in strip linings are seldom wider than 6 in., more commonly 4 in., and in addition to having welded seams, are slot-welded or plug-welded on 4-in. centers. After linings have been applied, the vessel must be tested, leaks located, imperfect welds chipped out and repaired, and this procedure repeated until satisfactory tightness is achieved.

In fabricating a new vessel in the average shop, clad steels are generally most economical, and have the further advantage of providing a smooth internal surface that is difficult or impossible to obtain with strip linings.

Strip linings, however, are most economical to apply where a vessel has been fabricated of carbon steel and operating experience has shown that a small localized portion must be protected against corrosion.

The total cost of providing clad protection in this crude fractionator overhead condenser and accumulator was approximately $4,000. Over a six-year period, the annual saving in maintenance costs added up to better than $5,000. Certainly, when an installation pays out in 282 days it can be considered an unqualified success.

Clad Steel Properties

The most economical solution to a corrosion problem may lie in using clad steel instead of a heavier carbon steel or a more expensive solid alloy steel, because of additional properties in the clad metal besides corrosion resistance. Among these are: 1) mechanical properties equal to or greater than the tensile strength of A-285, Grade C, flanging quality steel; 2) ease of fabrication;

Table 1—Clad Steels Commonly Used for Refinery Vessels

Corrosive	Temp. °F.	Stainless	Nickel	Monel	Inconel
HCl, gas	.....	.....	Regular	.....	Regular
HCl, very dilute	.....	.....	Regular	Regular	.....
Caustic, conc.	650	.....	L Type	.....	.....
Caustic, dilute	400	.....	Regular	Regular	.....
H_2S	above 500	410, 304, 405	.....	.....	.....
H_2S	below 500	316, 347	.....	Regular	.....
Furfural	300–500	410, 304, 347, 405	.....	Regular	.....
Phenol	300–500	410, 304, 347, 405	Regular	Regular	.....
Naphthenic acid	room–900	316	.....	Regular (below 500F)	Regular
Chlorinated solvents	room–300	.....	Regular	Regular	.....
Ethanolamine treater solution	room–400	304, 347	.....	.....	.....
Sulfuric acid, concentrated	.....	*	*	*	.....
Sulfuric acid, dilute to very dilute	room–250	316 ELC	.....	Regular	.....

* Carbon steel generally used for concentrated sulfuric acid.

Table 2—Thermal Conductivity of Materials

(Btu/hr/sq.ft./°F/in. thickness at 212° F.)

Mild steel	460
Nickel	420
Stainless steel, Type 410	160
Stainless steel, Type 304	105
10% Stainless-clad steel, Type 410	387
20% Stainless-clad steel, Type 410	334
10% Stainless-clad steel, Type 304	344
20% Stainless-clad steel, Type 304	247

3) higher heat transfer rate than solid stainless steel or stainless steel-lined vessels; 4) lower alloy electrode costs; 5) greater plate widths; and 6) lower initial costs.

Alloy clad steel consists of a layer of corrosion-resistant metal—such as nickel, Inconel, Monel, stainless steel, or copper—bonded permanently to a heavier backing plate of any desired ASME quality steel. Cladding thickness normally is 10 to 20% of total plate thickness. But it may be varied from 5 to 50%, as desired to suit operating conditions.

Typical corrosives encountered and clad steels commonly used in process vessels are indicated in Table 1. A comparison of thermal conductivities of several clad steels is shown in Table 2. Carbon steels have higher thermal conductivity than the stainless steels, particularly the austenitic grades. Therefore, stainless-clad steels have higher conductivity than the solid stainless steels, as the table indicates.

Welding & Fabrication

Savings can be realized in using extra wide clad steel plates, which are available up to 178 in. in width. Width "extras" are low in proportion to fabricating costs; therefore, using the widest possible plates will cut costs, labor, and fabrication time. A comparison of width extras and welding costs for 10% clad steel, converted to costs/lb. of plate material used, is shown in Fig. 1.

In the case of a ⅜-in. clad plate, fabricated in accordance with U-68 requirements: at $12.25/ft., the extra fabricating cost when using two 48-in. plates to make a 96-in. wide course by welding would be $0.087/lb. A single plate 96 in. wide would cost $0.010/lb. in width extras. This results in a saving of $0.077/lb., in addition to savings in production time and manhours.

A single plate 108 in. wide would have a width extra cost of $0.015/lb. The fabricating cost to join two 54-in. plates of ½-in. thickness, under U-69 construction, would be $0.043/lb., including $0.005 width extra. The saving with the single width plate would be approximately $0.028/lb.

Table 6 — Width of Chipped, Ground, or Gouged Groove, Clad Side

Plate Gage	10% Clad	20% Clad
7/16 to ½ in.	7/16 to 9/16 in.	7/16 to ⅝ in.
9/16 to 1 in. (incl)	¾ to ⅞ in.	¾ to ½ in.
1 to 2 in.	7/16 to ⅝ in.	7/16 to ¾ in.

NOTE: A torch which incorporates a carbon arc and compressed air jet may be used for removal of cladding, followed by a light grind before welding.

PRECAUTION: Use stainless steel wire brushes on clad side to remove electrode slag. Do not use ordinary steel brush. Use insulated electrode holders when welding corrosion-resistant material.

Table 3—Welding Electrodes for Clad Side

Cladding	For covering exposed steel with first pass or layer	For completing balance of weld	For welding alloy to steel (welds not exposed to corr.)
405	25-20, 25-12*	25-20, 25-12*	25-20, 25-12
410	25-20, 25-12*	25-20, 25-12*	25-20, 25-12
14-16Cr	25-20, 25-12*	25-20, 25-12*	25-20, 25-12
430	25-20, 25-12*	25-20, 25-12*	25-20, 25-12
301	25-20, 25-12	25-20, 25-12 19-9	25-20, 25-12
302	25-20, 25-12	25-20, 25-12 19-9	25-20, 25-12
304	25-20, 25-12	25-20, 25-12 19-9	25-20, 25-12
304 ELC	25-20Cb, 25-12Cb	25-20Cb, 25-12Cb 19-9Cb	25-20, 25-12, 25-20Cb, 25-12Cb
308	25-20, 25-12	25-20, 25-12 19-9	25-20, 25-12
321	25-20Cb, 25-12Cb	25-20Cb, 25-12Cb 19-9Cb	25-20, 25-12, 25-20Cb, 25-12Cb
347	25-20Cb, 25-12Cb	25-20Cb, 25-12Cb 19-9Cb	25-20, 25-12, 25-20Cb, 25-12Cb
309	25-20	25-20	25-20, 25-12
310	25-20	25-20	25-20, 25-12
316	25-20Mo	25-20Mo, 19-9Mo	25-20, 25-12, 25-20Mo
316 ELC	25-20Mo	25-20Mo, 18-12Mo, Cb	25-20, 25-12, 25-20Mo
"Stainless 20"	25-20, 25-12	"Stainless 20"**	25-20, 25-12
Low carbon Nickel	(Inco) 141	(Inco) 141	(Inco) 141, 142
Nickel	(Inco) 141	(Inco) 141	(Inco) 141, 142
Monel	(Inco) 140	(Inco) 140	(Inco) 140, 141, 142
Inconel	(Inco) 142	(Inco) 142	(Inco) 142, 25-20, 25-12

* Must be used under certain corrosive conditions.
** Mandatory for cover pass.

Table 4—Current Ranges Recommended for Alloy Electrodes

Electrode diameter	Chromium Steels and pure Nickel	Cr-Ni Steels and Monel	Inconel and 80Ni-20Cr
1/16 in.	100-130	70-105	80-100
5/64 in.	130-170	100-140	110-135
3/32 in.	170-210	130-180	135-160
1/8 in.	210-295	200-260	.....

Specific recommendations should be obtained from electrode mfgrs.

Table 5—Alloy Electrodes for Corner or Tee Joints and Overlays on Steel

Cladding Type	Electrode	Cladding Type	Electrode	Cladding Type	Electrode
405	25-20*	304 ELC	25-20Cb	316 ELC	25-20Mo
410	25-20*	308	25-20	"Stainless 20"	"Stainless 20"
430	25-20*	321	25-20Cb	Nickel	(Inco) 141
301	25-20	347	25-20Cb	Low carbon Ni.	(Inco) 141
302	25-20	309	25-20	Monel	(Inco) 140
304	25-20	316	25-20Mo	Inconel	(Inco) 140

* Chromium electrodes must be used under certain corrosive conditions.

A single plate 120 in. wide has a width extra costs of $0.016/lb. Two plates 60 in. wide, ⅜ in. thick, have a U-69 fabricating cost of $7.71/ft., plus a width extra of $0.005/lb., and would cost $0.052/lb. to join. This use of wide plate saves $0.036/lb., plus savings in shop time and equipment use.

Fabrication and welding data are summarized in Figs. 2 and 3 and in Tables 3, 4, 5, 6, and 7.

Table 7—Flame Cutting Clad Steels, Steel Side Up

(Table for use with natural gas or propane. For acetylene, use next larger tip)

Plate Gage, ins.	Cutting Speed in./min.	Cutting Pressure min.–max. lbs.	Orifice (Oxweld) diam., in.	Orifice (Airco) diam., in.
1/4	22-25	5- 7	0.04	0.0430
5/16	19-21	6- 8	0.04	0.0430
3/8	16-18	7-10	0.05	0.0520
½	15-17	10-12	0.07	0.0700
5/8	14-16	8-13	0.08	0.0785
¾	13-15	9-14	0.08	0.0785
1	12-14	10-16	0.10	0.1065
1½	10-12	12-18	0.12	0.1250
2	9-11	12-18	0.16	0.1660

NOTE: Openings can be cut successfully through clad vessels, using oxyacetylene cutting torch manually, without aid of powder. Lay out opening on steel side, 1/32 in. smaller than specified dimension and cut on center of layout line. To start cut, place lighted nozzle about 1 in. inside layout line and, when proper temperature is reached, pull trigger about half open, then start moving toward layout line. When layout line is reached, cut will have progressed through total thickness. Then pull trigger all the way, and continue on layout line until opening is cut out. This leaves a clean and fairly smooth cut which can be cleaned up with little grinding. Use table for selecting nozzles and cutting pressures.

TO HELP YOU DESIGN FRACTIONATORS

Stripping of Quaternary Mixtures

No. 3 in a Series

By ROBERT R. WHITE
Dept. of Chemical and Metallurgical Engrg.
University of Michigan

THE preceding papers of this series,[1, 2] have shown that the behavior of stripping and rectifying columns with ternary mixtures is similar to that with binary mixtures in that

1—The product compositions are a function of the reflux or reboil ratio.

2—The value of the minimum reflux or reboil ratio depends upon the separation specified.

3.—At the minimum reflux ratio, the composition of the zone of infinite stages is a function only of the feed composition and thermal condition and is independent of the separation specified.

The ternary mixtures differed from the binary mixtures in that the separation could be so specified that one of the end components (most or least volatile) would disappear at the minimum reflux or reboil ratio yielding a binary zone of infinite stages. Even so, the composition of the binary zone is dependent only upon feed properties and independent of the separation specified except in so far as whether or not a binary instead of a ternary zone of infinite stages developed at the minimum reflux or reboil ratio. Further, it was demonstrated that fractionation from the binary zone followed a unique path fixed only by the feed properties.

Quaternary Mixtures

The analysis of the distillation of ternary mixtures may now be extended to four-component or quaternary mixtures. Four components constitute the simplest multicomponent system and the basic relationships which apply to quaternary systems apply in general to mixtures containing more components.

It is convenient to represent the composition of quaternary mixtures in a set of coordinate axes as shown in Fig. 1 where the mole fractions of three of the components may be plotted in the "x", "y", and "z" directions. Since the sum of the mole fractions must be unity, the locus of all possible quaternary mixtures is enclosed within the confines of a right angled tetrahedron as shown. Such figures are useless in making quantitative calculations but are invaluable in following the effects of various operating variables in distillation calculations qualitatively. Since the composition of a quaternary mixture may be represented by a point within the tetrahedron of Fig. 1, the location of equilibrium tie lines connecting the compositions of equilibrium liquid and vapor phases may be represented as illustrated by the line *LV*.

Material Balances

Where it is necessary to make material balances for a distillation column in which constant molal overflow conditions exist, it is possible to represent such balances by the "proportional segment" or "lever arm" principle just as in the case of the projected ternary enthalpy-composition diagram shown previously (Fig. 3, Ref. 1). In Fig. 1 for example, the point *O* represents the sum of streams *A* and *B* represented by the points *A* and *B*, the point *O* being located on the straight line *AB* so that the ratio of the stream quantities *A*/*B* is equal to the ratio of the line segments *OB*/*OA*. Thus, all of the operations pictured on the ternary composition diagrams of the previous papers may also be represented by solid diagrams such as Fig. 1.

Stripping Columns

Consider the stripping of the saturated feed liquid containing components *a*, *b*, *c*, and *d* listed in the order of decreasing volatilities to produce a bottom product specified by fixing the concentration of the most volatile component in the bottom product, x_{aB}.

The specification of the concentration of the most

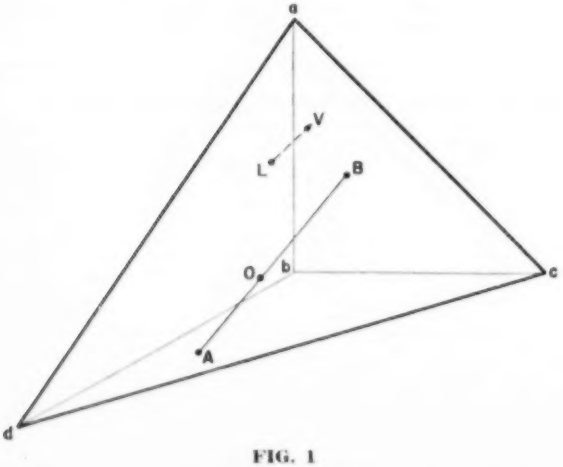


FIG. 1

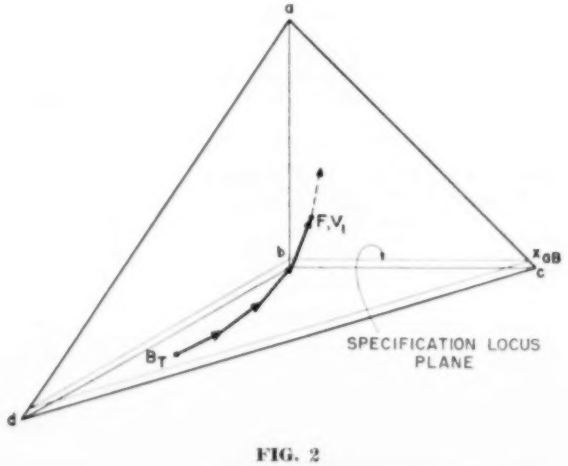


FIG. 2

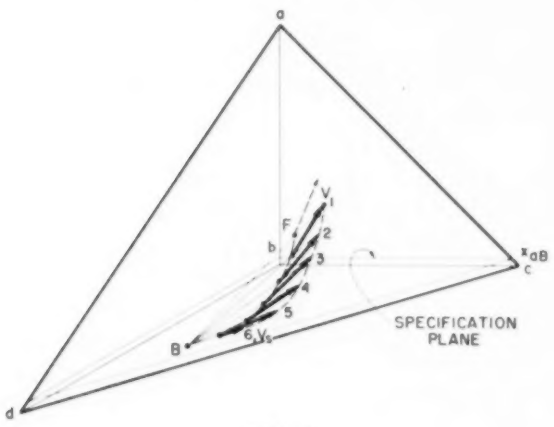


FIG. 3

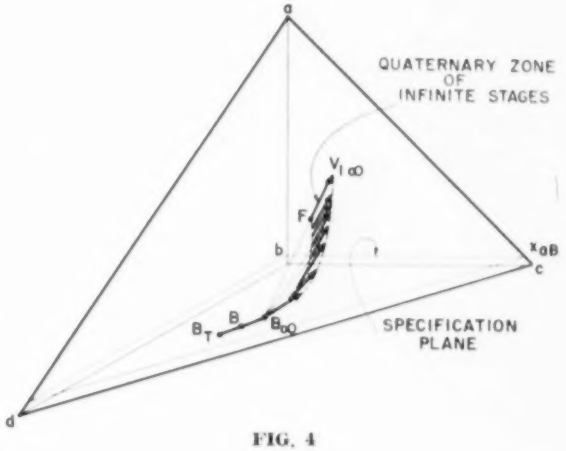


FIG. 4

volatile component in the bottom product is shown in Fig. 2 by the plane drawn at x_{aB} = constant, the point F representing the feed stream. At a reboil ratio of infinity corresponding to total reflux operation, as in the case of ternary mixtures, the overhead vapor composition is the same as that of the feed, and stage-to-stage calculations may be begun with the overhead vapor using the same procedures as were outlined previously terminating at some point such as B_T in the specification plane.

At a finite reboil ratio it is necessary to assume a bottom product composition, calculate the overhead vapor composition through a material balance using the fixed value of the reboil ratio and make stage-to-stage calculations to check the assumed bottom product calculation. Such a completed calculation is illustrated in Fig. 3. As the reboil ratio is decreased, until an infinite number of stages is required, the bottom product composition shifts along a curve such as B_TB to the point B_∞, in Fig. 4, which lies at the intersection of the equilibrium tie line through the feed point and the specification plane of constant x_{aB}. The zone of infinite stages and constant composition in such circumstances occurs at the top stage, equilibrium being reached between the feed stream and the overhead vapor $V_{1,\infty}$. The value of the minimum reboil ratio is given by the relative distance BF/FV_1. This behavior is similar in all respects to that of ternary systems as illustrated previously.[1, 2]

Fig. 4 makes the calculation of the minimum reboil ratio self-evident. For example, if the feed stream contains 0.25 mol fraction each of components a, b, c, and d having volatilities of 3.375, 2.25, 1.50 and 1.00, respectively, and if the bottom product must contain a mol fraction of component a equal to 0.01, the calculation consists of computing the equilibrium vapor composition from the feed composition and evaluating the ratio of distances BF/FV_1 as shown in Table 1.

The specification of the concentration of the least volatile component in the bottom product, x_{dB} is illustrated in Figs. 5, 6, and 7.

In Fig. 5, the bottom product specification is so fixed that the equilibrium tie line through the feed point F intersects the specification plane within the diagram at the point B_∞. The location of the bottom product at a reboil ratio of infinity, at finite ratios and at minimum reboil ratio is similar in all respects to the behavior illustrated in Fig. 4, the bottom product B_T at infinite reboil ratio shifting to B_∞ at the minimum reboil ratio along a curve B_TB_∞ in the specification plane. The zone of infinite stages and constant composition develops at

Table 1

Component	Feed Composition Mole Fraction $x_{j,F}$	Relative Volatility α_j	$\alpha_j x_j$	Overhead Vapor Composition $y_{j,1} = \frac{\alpha_j x_j}{\Sigma \alpha_j x_j}$
a	0.25	3.375	0.84375	0.415
b	0.25	2.25	0.5625	0.277
c	0.25	1.50	0.375	0.185
d	0.25	1.00	0.25	0.123
			$\Sigma \alpha_j x_j = 2.03125$	1.000

Then

$$\left(\frac{V_s}{B}\right)_{min} = \frac{B_\infty F}{B_\infty V_1} = \frac{x_{aF} - x_{aB}}{y_{1a} - x_{aB}} = \frac{0.25 - 0.01}{0.415 - 0.01} = 0.5925$$

Table 2

Component	x_{j,B_p}	$(L/V-1)x_{jB_p}$	α_j	if $K_r = 0.594$ $\alpha_j K_r$
b	0.209	0.13794	2.25	1.3365
c	0.349	0.23034	1.50	0.8910
d	0.442	0.29172	1.00	0.5940

$L/V-\alpha_j K_r$	$x_{j,\infty} = \frac{(L/V-1)x_{jB_p}}{(L/V-\alpha_j K_r)}$	$\alpha_j x_{j,\infty}$	$y_{j,\infty} = \frac{\alpha_j x_{j\infty}}{\Sigma \alpha_j x_{j\infty}}$
0.3235	0.426	0.9585	0.570
0.769	0.300	0.4500	0.267
1.066	0.274	0.2740	0.163
	$1.000 \Sigma \alpha_j x_j$	1.6825	1.000

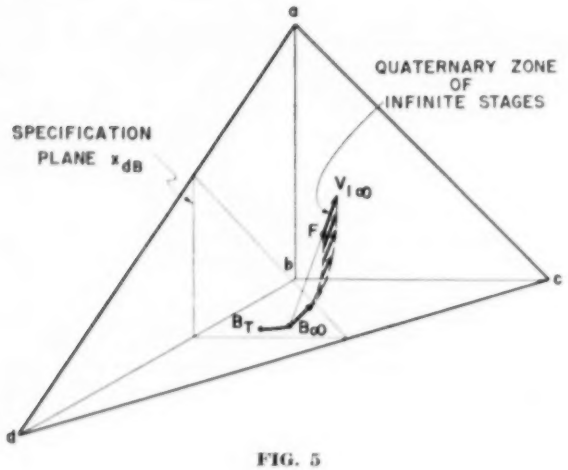


FIG. 5

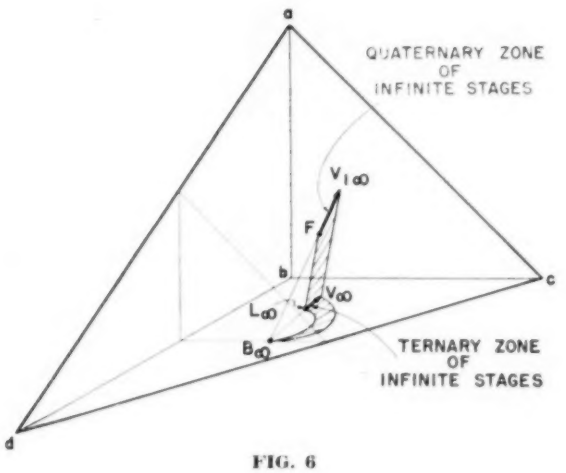


FIG. 6

the feed stage and the value of the minimum reboil ratio is $V_s/B = B_\infty F/FV_{1,\infty}$.

When the concentration of the least volatile component in the bottom product is specified at the same value, x_{dB}, as the x_d coordinate of the intersection of the equilibrium tie line through the point F with the bcd plane, as shown in Fig. 6, the bottom product composition shifts from the point B_T at infinite reboil ratio to the intersection point B_∞ at the minimum reboil ratio. This case is analogous to that shown in Fig. 2, Ref. 2 for ternary systems. In this case, two zones of constant composition develop simultaneously as the reboil ratio is decreased to the minimum value. One of these zones occurs at the feed stage and, since the bottom product contains a zero concentration of component a, the other zone of constant composition occurs in the bcd face of the diagram and consists of a ternary system as illustrated in Fig. 6. The minimum reboil ratio V_s/B is equal to the distance ratio $\overline{FB_\infty}/\overline{V_{1,\infty}F}$. As outlined in discussing Fig. 2, Ref. 2, fractionation from the ternary zone of constant composition follows the two straight and parallel lines FL_∞ and $V_{1,\infty}V_\infty$.

The calculation of the bottom product composition at total and finite reboil ratios is similar to that previously discussed. The composition of the ternary zone of infinite stages may be calculated from the composition of the bottom product B_∞, the minimum reboil ratio and Equation 1.[2]

$$\Sigma x_{i,\infty} = 1.0 = \sum \frac{(L/V - 1)x_{i,B}}{L/V - \alpha_i K_r} \qquad (1)$$

Equation 1 is solved by assuming various values of K_r until the indicated summation is 1.0.

When the concentration of the least volatile component in the bottom product, x_{dB}, is specified at a higher value than the x_d coordinate of the equilibrium tie line through the point F at $x_a = 0$, the bottom product composition is determined as shown in Fig. 7. As the reboil ratio is decreased the bottom product shifts to the point B_∞ at the minimum reboil ratio, the concentration of component a, in the bottom product, x_{aB}, reaching zero at the minimum reboil ratio. The point B_∞ may be located by extrapolating the line $V_\infty L_\infty B_P$ to the specification plane. The ternary zone of constant composition is the same as that shown in Fig. 6 and may be computed from the feed point as described previously. The overhead vapor product V_1 at minimum reboil ratio may be located from the intersection of the line $B_\infty F$ with the line $V_{1,\infty}V_\infty$. The path of the fractionation is shown in Fig. 7 and the reboil ratio V_s/B_∞ is equal to the relative distance $\overline{B_\infty F}/\overline{FV_1}$.

Consider now the case where the concentration of the least volatile component in the bottom product, x_{dB}, is equal to the x_d coordinate of the point of intersection of the equilibrium tie line of the ternary zone of constant composition of Fig. 6 with the line cd as shown in Fig. 8. As the reboil ratio decreases to its minimum value, the bottom product composition approaches that represented by the point B_∞, both components a and b disappearing completely at the minimum reboil ratio.

Since the bottom product at the minimum reboil ratio is now a binary mixture, a binary zone of constant composition develops along the line cd as shown in addition to the ternary zone at $L'_\infty V'_\infty$. The path of the fractionation above the zone of constant composition follows the straight parallel lines FL'_∞ and $V_1V'_\infty$, and $L'_\infty L_\infty$ and $V'_\infty V_\infty$. The overhead vapor V_1 in Fig. 8 lies at the intersection of the line $B_\infty F$ in the line through $V_\infty V'_\infty$. The reboil ratio, V_s/B is equal to the relative distance $\overline{B_\infty F}/\overline{FV_1}$.

Where the concentration of the least volatile component in the bottom product, x_{dB}, is specified at a greater value than the x_d coordinate of the intersection of the equilibrium tie line of the ternary zone of constant composition of Fig. 6 with the binary edge, the bottom product at the minimum reboil ratio will again be a binary mixture as shown in Fig. 9, both x_{aB} and x_{dB} going to zero as the reboil ratio approaches the minimum value. Again the binary zone of constant composition occurs along the line cd and has the same concentration as the zone shown in Fig. 9. The minimum reboil ratio V_s/B is equal to the relative distance $\overline{L_\infty B_\infty}/\overline{L_\infty V_\infty}$.

As fractionation proceeds up the column above the binary zone of constant composition $L_\infty V_\infty$ along the path of the curved lines $L_\infty F$ and $V_\infty V_1$ until the overhead vapor V_1 is reached. This point lies on the curved line $V_\infty V_{1\infty}$ and on the straight line $B_\infty F$.

It should be emphasized that in each of these cases

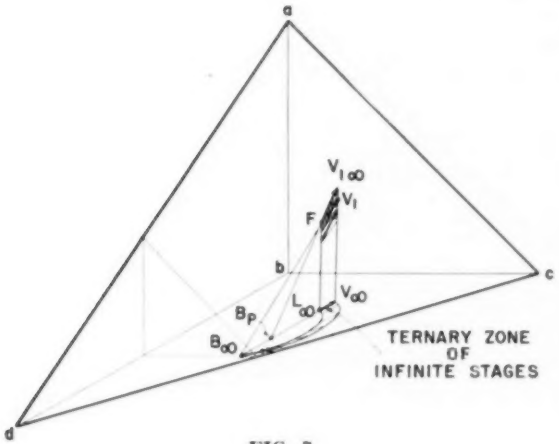


FIG. 7

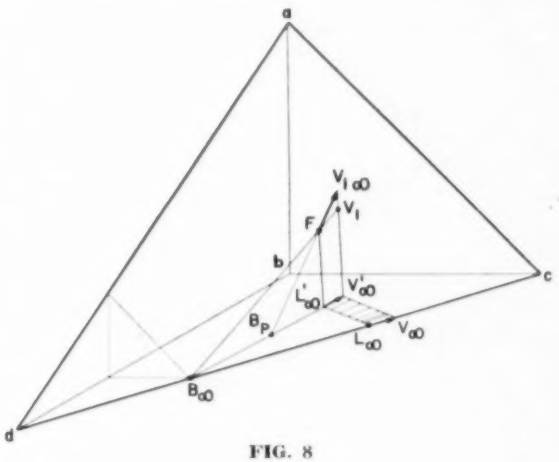


FIG. 8

the composition in the various zones of infinite stages in the foregoing diagrams are functions only of the feed composition and thermal condition and are dependent upon the separation specified only insofar as determining which zone of infinite stages limits the reboil ratio to its minimum value.

The foregoing relationships for a stripping column may be clarified by the solution to the following example.

Example Problem

A saturated liquid feed containing 25.0 mol % each of components *a*, *b*, *c*, and *d* having relative volatilities 3.375, 2.25, 1.50, and 1.00, respectively, is to be stripped to produce a bottom product containing the following concentrations of component *d*:

$$1\text{—}x_{dB} = 0.40$$

$$2\text{—}x_{dB} = 0.442$$

$$3\text{—}x_{dB} = 0.550$$

$$4\text{—}x_{dB} = 0.602$$

$$5\text{—}x_{dB} = 0.800$$

Compute the minimum reboil ratios, the compositions of the bottom product and of the infinite stage zones in each case.

Solution:

Calculation of Possible Zones of Infinite Stages.

A—Quaternary Zone at the feed stage, overhead vapor in equilibrium with saturated liquid feed, as shown in Table 1.

B—Ternary Zone:

Extrapolation of Feed Tie Line to $x_a = 0$ (plane *bcd*) to determine point B_p in Figs. 6-9.

Table 3

Component	x_{j,B'_p}	$(L/V-1)x_{jB'_p}$	α_j	if K_r
c	0.398	0.1345	1.50	1.
d	0.602	0.2035	1.00	0.
=0.755	$L/V-\alpha_jK_r$	$x_{j\infty}$	$\alpha_j x_{j\infty}$	$y_{j\infty}$
α_iK_r				
1325	0.2055	0.652	0.978	0.7375
7550	0.5830	0.348	0.348	0.2625

By the proportionality of the line segments V_1FB in the "a" and "i" directions

$$\frac{y_{i,1} - x_{i,F}}{x_{i,F} - x_{i,B}} = \frac{y_{a,1} - x_{aF}}{x_{a,F} - x_{a,B}} \qquad (2)$$

Rearranging and substituting the equilibrium relation

$$y_{i,1} = \frac{\alpha_i x_{i,F}}{\Sigma \alpha_j x_{jF}},$$

the concentration of any component *i* at $x_a = 0$ is

$$x_{i,B} = x_{i,F}\left[\frac{\alpha_a - \alpha_i}{\alpha_a - \Sigma\alpha_j x_{jF}}\right] \qquad (3)$$

Substituting the numerical values of Table 1 in Equation 3,

$$x_{bB'_p} = 0.250\,\frac{3.375 - 2.25}{3.375 - 2.03125} = 0.209$$

$$x_{cB'_p} = 0.250\,\frac{3.375 - 1.50}{3.375 - 2.03125} = 0.349$$

$$x_{dB'_p} = 0.250\,\frac{3.375 - 1.00}{3.375 - 2.03125} = 0.442$$

$$\overline{1.000}$$

The $\overline{L}/\overline{V}$ ratio by which the ternary infinite stage zone is calculated as in Fig. 6 is the relative distance

$$\frac{BV_1}{BF} = \frac{0.415 - 0}{0.250 - 0} = 1.660$$

The composition of the ternary zone is now calculated from Equation 1, as shown in Table 2.

C—Binary Zone:

Extrapolation of the Tie Line in the Ternary Zone of Infinite Stages to $x_b = 0$ to determine point *B'p* in Figs. 8 and 9 by an equation similar to Equation 3.

$$x_{cB'_p} = 0.300 - (0.267 - 0.300)\left(\frac{0.426 - 0}{0.570 - 0.426}\right) = 0.398$$

$$x_{dB'_p} = 0.274 - (0.163 - 0.274)\left(\frac{0.426 - 0}{0.570 - 0.426}\right) = 0.602$$

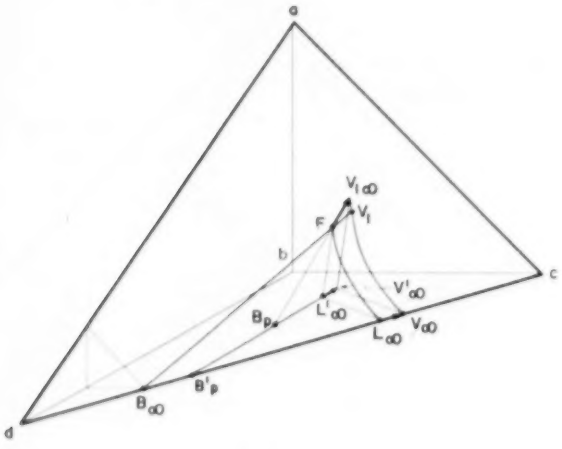


FIG. 9

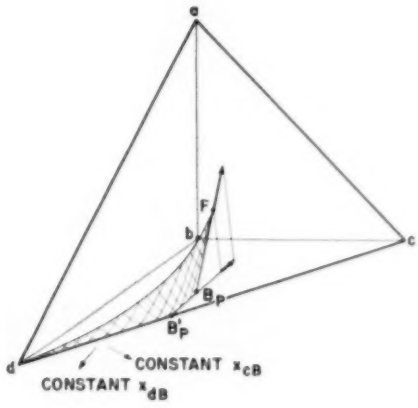


FIG. 10

The L/V by which the binary infinite stage zone is calculated as in Fig. 8 is the relative distance

$$\frac{B'_p V_\infty}{B'_p L_\infty} = \frac{(0.570 - 0)}{(0.426 - 0)} = 1.338$$

The composition in the binary zone of infinite stages is now calculated from Equation 3 as shown in Table 3.

1—When $x_{dB} = 0.40$, the feed tie line intersects the specification plane as in Fig. 5. The bottom product composition is represented by the point of intersection at minimum reboil ratio, thus by the proportionality similar to Equation 2.

$$x_{aB} = x_{aF} - (y_{a,1} - y_{aF}) \frac{x_{dF} - x_{dB}}{y_{d1} - x_{dF}}$$

$$= 0.250 - (0.415 - 0.250) \frac{0.250 - 0.400}{0.123 - 0.250} = 0.055$$

$$x_{bB} = 0.250 - (0.277 - 0.250) \frac{0.250 - 0.400}{0.123 - 0.250} = 0.218$$

$$x_{cB} = 0.250 - (0.185 - 0.250) \frac{0.250 - 0.400}{0.123 - 0.250} = 0.327$$

$$x_{dB} = 0.400$$

$$1.000$$

The composition in the infinite stage zone is given by the feed tie line and

$$\frac{V_s}{B} = \frac{\overline{BF}}{\overline{FV}_1} = \frac{(0.400 - 0.250)}{(0.250 - 0.123)} = 1.180$$

2—When $x_{dB} = 0.442$, the feed tie line intersects the specification plane at $x_a = 0$ so that both the ternary and quaternary zones of infinite stages develop at minimum reboil ratio. The bottom product is given by x_{j,B_p} in Table 2 and illustrated by Fig. 6.

$$\frac{V_s}{B} = \frac{(0.250)}{0.415 - 0.250} = 1.517$$

3—When $x_{dB} = 0.550$ a ternary zone of infinite stages develops as in Fig. 7, the point representing the bottom product lying on the extrapolation of the tie line in the ternary zone, thus

$$x_{aB} = 0.000$$

$$x_{bB} = 0.426 - (0.570 - 0.426) \frac{0.274 - 0.550}{0.163 - 0.274} = 0.070$$

$$x_{cB} = 0.300 - (0.267 - 0.300) \frac{0.274 - 0.550}{0.163 - 0.274} = 0.382$$

$$x^*_{dB} = 0.550$$

$$1.002$$

The minimum reboil ratio is

$$\frac{V_s}{B} = \frac{BL_\infty}{L_\infty V_\infty} = \frac{(0.550 - 0.274)}{(0.274 - 0.163)} = 2.49$$

4—When $x_{dB} = 0.602$, the tie line in the ternary zone intersects the specification plane at $x_d = 0$ as in Fig. 8, so that both the binary and ternary zones of infinite stages develop at minimum reboil ratio. The bottom product is given by x_{j,B_p} in Table 3.

$$\frac{V_s}{B} = \frac{(0.602 - 0.274)}{(0.274 - 0.163)} = 2.96$$

5—When $x_{dB} = 0.800$, the binary zone of infinite stages develops as in Fig. 9, the product being a binary mixture in which $x_{cB} = 0.200$. The composition of the binary zone given in Table 3 permits the calculation of

$$\frac{V_s}{B} = \frac{BL_\infty}{L_\infty V_\infty} = \frac{(0.800 - 0.348)}{(0.348 - 0.2625)} = 5.30$$

The surface shown in Fig. 10 represents all of the bottom products which can be made from a feed represented by the point F. The upper edge of the surface is bound by all of the products which can be made at total reflux. The boundary designated by the lines $dB'_p B_p F$ includes all of the bottom products that can be made with an infinite number of stages (operation

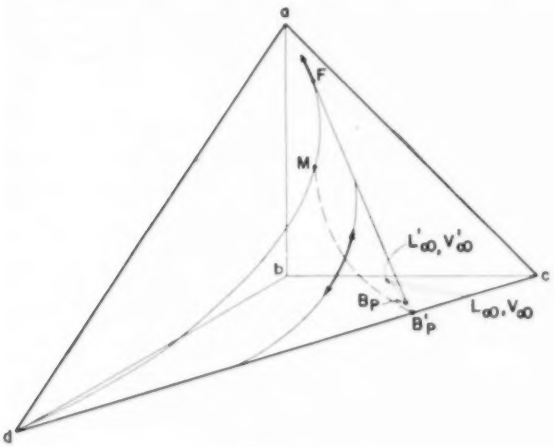


FIG. 11

at minimum reboil ratio). The lines in the surface are drawn at constant values of x_{dB} and x_{cB}. The arrows indicate the direction of change in the composition of the bottom products at specific values of x_{dB}. This figure is analogous to Fig. 4, Ref. 2 for ternary systems.

Again, when the feed material contains a high concentration of the less volatile components and the concentration of a component of intermediate volatility is specified, the curious behavior previously shown in Fig. 5 Ref. 2 for ternary systems may be encountered as shown in Fig. 11. There is a maximum concentration of component c which can be made at total reflux represented by the point M. Higher concentrations of component c can be obtained only at lower reboil ratios and again the bottom product may shift in either of two directions as indicated in Fig. 11. The complication introduced by specifying the concentration of a component of intermediate volatility is apparent.

Recapitulating, the behavior of quaternary systems in stripping columns is similar in every respect to the behavior of ternary and binary systems and the following statements therefore apply to systems of any number of components greater than two:

1—The overhead vapor composition is a function of the reboil ratio.

2—The bottom product composition is a function of the reboil ratio.

3—The value of the minimum reflux ratio is a function of the separation specified and the manner of specification.

4—The composition obtained in the zones of constant composition at the minimum reboil ratio is a function primarily of the feed composition and thermal condition and is a function of the separation specified only with respect to the number of components whose concentration goes to zero at minimum reflux.

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(1) White, R. R., PETROLEUM PROCESSING, 8, 357 (1953).
(2) White, R. R., PETROLEUM PROCESSING, 8, 539 (1953).

LARGEST FOAM UNIT built to date is the makers' description of Richfield Oil Co.'s new fire truck, designed to meet company's quest for "pumphouse on wheels". Makers also claim it achieves most precise proportioning of foam and water yet developed.

Fire truck carries two 1,000-lb. dry chemical tanks (sodium bicarbonate) with discharge rate of 1,300 lbs. per minute and 800 gal. of foam. Automatic mixing in proportion of 5% foam and 95% water produces 250,000 gal. of mixture in 13 minutes—more than would be normally available in stationary tanks.

There are 12 hose lines: Four 1-in. lines for dry chemical and eight 2½-in. lines for water or foam or both. Makers say one man can operate the truck, but in full use there is equipment for 40 fire-fighters.

Mobile self-sufficiency, rendering dependence on water connections of secondary importance, enhances value at a refinery.

This $40,000 unit has a 276-horsepower, double-ignition engine with specially designed cooling system and can deliver 1,800 gpm of water. Fully loaded, it weighs 30,600 lbs.

Mobile pumphouse took two years to design, a year to build and went into service at Richfield's Wilmington refinery in March.

At a public demonstration, firefighters using four dry-chemical lines snuffed out simulated pipe-trench fire in 15 seconds after 50-second pre-burn. Pit measuring 40 ft. by 10 ft. contained 16 in. of oil topped with 10 gal. of gasoline.

Other fires depicting typical refinery blazes were simulated broken elevated line off top of various vessels, open structure with simulated rupture of overhead line, simulated open-top trench fire and spill fire.

Equipment suppliers include: Seagrave Manufacturing Co., Columbus, Ohio (chassis and engine); Yankee Motor Bodies, Los Angeles (body); Ansul Chemical Co., Los Angeles and Marinette, Wisc. (chemicals and chemical tanks); Horn Fire Equipment Co. (fire-fighting apparatus).

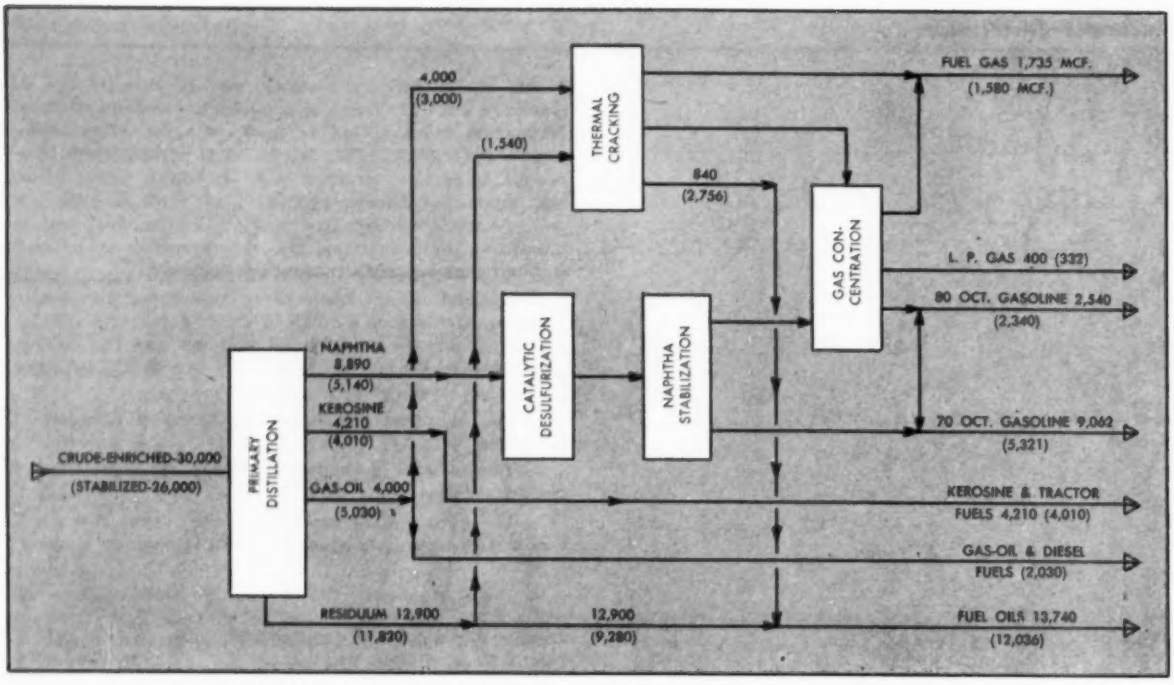


FIG. 1—Schematic block diagram of Salamanca process operations

Refining in Mexico—Part Four

Pemex Building New Lube Plant

Modern solvent extraction facilities being installed at Salamanca to supply the lubricants and wax trade

By D. P. THORNTON, Jr.
Southwestern Editor

ALTHOUGH only two years old, the refinery of Petroleos Mexicanos at Salamanca is already beginning a major expansion, to install a plant to make 2,500 bbl. daily of finished lubricating oils and 65 tons a day of finished waxes.

The present refinery, of 30,000 b/d crude charging capacity, has lifted an enormous load from the only other refinery now serving the central area of Mexico, the Pemex plant at Atzcapotzalco. It also receives its crude supply from Poza Rica by pipeline. Salamanca was built by Arthur G. McKee Co., Cleveland, at a cost of $15,500,000.

The new lubricants facilities at Salamanca will take two years to build and cost $15,000,000 in materials alone. The lube unit will have the effect of increasing crude throughput by 10,000 b/d, to 40,000 bbls. total, through larger transfer lines, bigger pumps and more heat exchangers to be installed in the existing topping unit at the same time the lubricating oil facilities are built.

This new unit will be able to supply the domestic solvent lubricating oil requirements of Mexico, with or without operation of the conventional lube plant (already inadequate) at Minatitlan. The added wax capacity will supplement that of the Madero refinery at Tampico. It will make possible the elimination of some $6,000,000 of lube stocks now imported by Pemex annually, for the most part from the U. S.

Lubricating oils also are imported by other agencies under brand names for private sale through independent stores and garages. These importations presumably will not be effected by the new lube plant, unless a definite change in policy is made by the Mexican government. Lube additives will continue to be imported as in the past; none are made in Mexico.

This highly-flexible Salamanca plant will charge 50% reduced crude from the topping unit, taking off three side streams in a vacuum column, and propane deasphalting the bottoms. The design also provides for the future possibility of preparing feed stocks for eventual catalytic cracking without interfering with the lube operation, according to the McKee company.

By "slopping" the overhead fractions and subsequently rerunning them, it will be possible for the unit to provide eight basic lubricating oil stocks including neutral oils, bright stocks and spindle oils. All stocks will be solvent extracted with furfural and dewaxed with methyl-ethyl-ketone. A wide variety of lubricating oils, transformer oils, and a complete line of greases will be made.

The Salamanca unit will be able to produce six basic stocks for the preparation of finished waxes. Some wax stocks now produced at the Madero refinery in Tampico may be shipped to Salamanca for dewaxing and the dewaxed oils used to supplement present Diesel fuel production. All told 65 tons per day of various grades of finished waxes will be made.

Aside from technical details, one unusual fact about the new lube plant is that it is being financed by an issue of $20 million (U. S.) in National Savings Bonds, wherein the private investor is promised double his money back in ten years. Although such bonds have been used in Mexico for some time past to finance housing projects and agricultural ventures, this marks the first time an oil industry project has been so financed. The response from the public has been favorable.

In this connection, it should be pointed out that Pemex is not sponsoring the bond issue or selling the bonds; it is borrowing the money with the lube plant as security. Up to the present time, industry in general has not found it convenient to secure financial backing in Mexico as is done in the U. S., by loans from banks, insurance companies and other financial institutions. By reason of its ownership Pemex is not able to issue stock, another favorite method of securing capital in the U. S.

Table 1—Typical Day Operation at Salamanca (Tank Gages)

McKee Topping Unit Charge	b/d
Poza Rica enriched crude	30,000
Production	
S R Gasoline	7,400
Kerosine	2,620
Gas oil	4,150
Reduced Crude	14,050
Total Products	28,220
(Gas & Loss, diff.	1,780)

Dubbs Cracking Charge	b/d
Reduced Crude	3,680
Gas oil	2,050
Total	5,730
Production	
Cracked gasoline	2,350
I & N Butanes	310
Propane	270
Fuel Oils	2,750
Total	5,680
(Gas & Loss, diff.	50)
Recycle ratio	3.2:1

Perco Desulfurization Charge	b/d
S R Gasoline	8,800
Cracked gasoline	2,350
Total	10,150

Current Operations

The major processing units currently in use at Salamanca are a McKee primary distillation unit of 30,000 b/d capacity when charging enriched crude (26,000 b/d on depropanized Poza Rica crude) and a Dubbs thermal cracking unit of 4000 b/d capacity when charging gas oil (4540 b/d of a mixture of 1540 bbls. residuum and 3000 bbls. of gas oil). Incorporated in the Dubbs unit is provision for stabilizing, de-ethanizing and depropanizing of light ends in addition to the usual synthetic crude distillation tower.

A schematic block diagram of processing operations at Salamanca is shown in Fig. 1. Quantities shown for the various products apply when charging Poza Rica enriched crude while those in parenthesis are for stabilized crude operation only. A typical day's operation as indicated by tank gages is shown in Table 1. The plant then was producing only regular grade motor fuel and consequently was charging an excess over production of straight-run gasoline from storage.

Salamanca has successfully averaged between 90 and 95% on-stream efficiency since operations commenced. Mechanically, it is in excellent shape, well-painted. Good housekeeping is a "must." Experience is responsible for customarily operating the McKee unit for approximately one year between turnarounds, when it is down for about seven days.

The crude reaching Salamanca from time to time is quite salty, with concentration as high as 150-160 lbs./1000 bbls. There are no desalting facilities consequently there have been difficulties with plugged heater and exchanger tubes, although ammonia injection has minimized the latter. A heater washing technique has been developed to solve this recurring problem without seriously affecting throughput rates.

The flow to the heaters is temporarily interrupted when pressure drop, effective loss of heat transfer or visual inspections indicate imminent plugging or that salt deposits have developed. The fire is cut off. The tubes are allowed to cool as rapidly as is safe by blowing first with steam and then with air, until the indicated surface temperature reaches approximately 212° F. Water then is turned into the tubes and fires relighted to maintain a temperature of approximately boiling until washing is complete. This takes about six hours.

The final operation consists of blowing the tubes dry with air while firing is pushed to bring them to operating temperature as crude flow is re-established and the heater returned to the line.

A very appreciable saving in off-stream time is effected over manual cleaning. Since there are two heaters in parallel, simple scheduling insures that only one heater will be down for washing at one time, thereby avoiding bringing the whole unit down for the eight hours or so a heater actually is out of service.

The thermal cracking unit is effectively a two-coil operation, one of the heaters charging light ends split from the reduced crude or a mixture of reduced crude and gas oil, while the other handles the heavy bottoms. A recycle ratio of 4.25 to 1 of charge is maintained through the heaters. Ratio of heavy liquid to light liquid is 1.9:1, the two streams being of 18° (K factor 10.8) and 26° API gravity (K, 10.85) respectively.

The cracked liquid then is soaked and successively flashed at 130 and 30 psi. Thermal gasoline taken overhead from the first flash is returned to the fractionator taking the fresh charge and eventually goes overhead to gas recovery and stabilization. Gas made on this unit is used as refinery fuel.

The gas-concentration and gasoline stabilization section of the unit is not unusual. A side-stream of gasoline is used as absorption oil and returned to the main fractionator. The cracked gasoline is stabilized and the overhead is sent to the gas treating plant for removal of hydrogen sulfide (Girbotol process employing diethanolamine).

Products Treating

The Perco catalytic desulfurization unit is of conventional design and was the first catalytic unit of any type to be used in petroleum refining in Mexico. It served as the prototype for two others, recently completed at Atzcapotzalco and the Madero refinery in Tampico. The desulfurizer charges either straight-run gasoline alone or a mixture of straight-run with thermally cracked gasoline at the design rate of 11,600 b/sd.

The high sulfur content of the Poza Rica crude makes catalytic desulfurization a very necessary part of the refinery scheme, not only to remove organic sulfur but also to reduce the amount of tetraethyl lead required to meet octane specifications. The practice is to charge all the gasoline produced, but the composition of the charge between straight-run and cracked gasoline is dictated by the relative needs for premium and regular grades of gasoline. Reforming is also possible with this unit.

Subsequent to desulfurization and stabilization the straight-run gasoline, cracked gasoline, or mixtures of the two are washed with caustic soda to remove remaining traces of hydrogen sulfide and mercaptans not otherwise removed. The stabilized straight-run has been depropanized only, whereas cracked gasoline also has been debutanized, but the treating step in this case is separate for the stabilizer product and light ends.

Kerosines are doctor-treated. The unit has capacity for 3000 b/d. A caustic-regeneration unit of 700 b/d is provided, utilizing simple steam stripping.

Plant Utilities

Unlike its sister-plant the Atzcapotzalco refinery at Mexico City,

the Salamanca refinery does not receive any Poza Rica natural gas; hence it depends on gas produced in its own operations to supplement residual fuel as the primary source of heat for process steam and power. The plant is approximately half-and-half steam and electric-driven normally, but the ratio can be adjusted at need.

The plant has two 60,000 lbs./hr. oil, or gas-fired, Combustion Engineering boilers producing steam at 275 psig. One 3750-Kva Westinghouse turbogenerator is installed and, in addition, there are three 775 Hp. Cooper-Bessemer Diesel engines driving 675 Kva Westinghouse generators.

Both steam and electric generating facilities are being expanded to meet the needs of the new plant which is scheduled for completion by winter, 1954. Among major installations are four turbogenerators of 3750 Kva each, delivering power at 6600 v. Since the present plant equipment furnishes power at only 2400 v., interconnection of the two systems will be effected through transformers. When this is done most of the prime movers will be electric driven and spared with steam.

At the present time the greater part of the refinery products are moved by tank car from a 100-car loading rack; about 90 cars daily are normally handled. Connections are available to service 60 cars with gasoline while the remaining spots are reserved for kerosine, Diesel and heavy fuels. In addition, a products pipe line now is being constructed northwest-ward to Lagos de Moreno, whence it will split to Aguascalientes and Guadalajara. The line now is in use as far as Lagos.

One of the most modern tank car repair shops in Mexico is located at Salamanca, far out on the refinery property to minimize fire hazards. The main building has three tracks and can accommodate up to 20 cars. These shops can repair almost any broken part for a car and, in a pinch, could almost build one from the ground up. Employing a crew of 90 men, the shops can handle a complete cleaning, painting and sign stenciling in under 24 hours.

Employe 'Colony'

A large area for employes, and cottages for special refinery guests have been provided. These are being increased in number to serve the influx of new employes which will begin soon and for which facilities in nearby Salamanca are inadequate. Included in the colony area are recreation facilities, a community hall, cafeteria and stables for riding horses. Housing follows more closely the American style than Mexican architecture and quarters for bachelors as well as families are provided.

As has so often happened in the U. S., the city of Salamanca expected boom days with the coming of the refinery. It anticipated addition to its population and jobs for a great many of its people. Adequately trained personnel for operating jobs were of course not available locally and most in fact were transferred from other Pemex refineries. However, as many local people as possible were given work in the new plant. The combination of building the camp and the misunderstanding over the employment question displeased Salamanca's citizenry, who retaliated by raising prices for foodstuffs and refusing to keep the highway route through the city in proper repair.

Today, the narrow highway leading west through the city towards Guadalajara is in abominable shape, as the writer can personally testify. To keep it passable at all the refinery must dispatch roadworking machinery frequently.

So upleasant is the road situation, however, that Pemex now has under consideration the construction of a private highway for the use of its trucks which will permit by-passing the city entirely. The present refinery entrance is beyond the city limits on the east side and Pemex already owns land on the west which was purchased originally to allow for future expansion of camp and refinery.

To get around high prices in Salamanca, the refinery now is leasing out a part of its unimproved property to an independent operator. He must sell the chickens, eggs and other produce he raises first to refinery personnel and the plant cafeteria at cost, in lieu of a formal rental fee. Any excess he may sell as he chooses. Extensive farming operations are being conducted and shortly a herd of beef cattle will be on the land as well as a dairy herd.

What's Mexico Like—outside the Refineries?

IF you ever want an automobile repair job done, we suggest you slip down to Mexico—and maybe you'd better take our southwestern Editor, Dave Thornton, with you.

At any rate; last summer our ever-alert accounting department came in one day, puzzled by an "exorbitant" item in Dave's expense account—a matter of some six bits for "car repairs." This was a matter of grave concern, so we sent off a query right away to Dave.

Eventually, his answer came in. And since he was now fast-becoming a genuine Mexicano, Dave's letter took a bit of time to get down to a direct reply to our question—mañana, you know. However, the complete letter gave us a better description of life in Mexico itself than had any of his more technical refinery "copy", or—obviously — his expense accounts. So, for your entertainment, here's Dave's reply (complete with details on the "car repair.")

"The motor trip from Mexico City to Salamanca was one of the highlights of exploring Mexico. Altitudes of more than 10,000 ft. are reached as one leaves the 'Valley of Mexico,' and crossing the Continental Divide becomes routine.

"One passes through Tolucca where your wife can buy her fill of baskets; Queretaro, where Emperor Maximilian was executed and you can learn how to drive over cobblestones; picturesque villages and extensive farm areas; miles of fields, where century plants are cultivated (from which come thread, pulque and tequila, cattle food, and a host of other things).

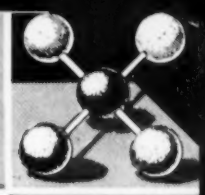
"There is no place to stay in Salamanca, but the more progressive city of Irapuato is only 18 minutes away. The writer entered Irapuato in a driving rain—part of a reported but unbelievable 20 inches which had fallen that day—to find the streets flooded. Also, the brakes had quit and it seemed that getting them wet just trying to find the hotel was not the complete cause.

"We had only two words in our Spanish vocabulary to describe the difficulty—'no frenos' (no brakes). We had lost the word for garage. Finally, an understanding traffic officer took pity on this unhappy 'tourista', stopped traffic, backed us by sign-language down a one-way street against the 'circulation' (traffic), and herded us into a garage which had no sign that we recognized.

"Here the chief mechanic—we suppose—and four boys ranging from 12 to 17 years old took off all the wheels, replaced a lost spring in one brake shoe assembly, repacked the bearings washed out the wheels with gasoline, and roughened the linings. A first-class job for the staggering sum of 75c, U. S! Hotel for one person, two nights, cost only $4.75, U. S.

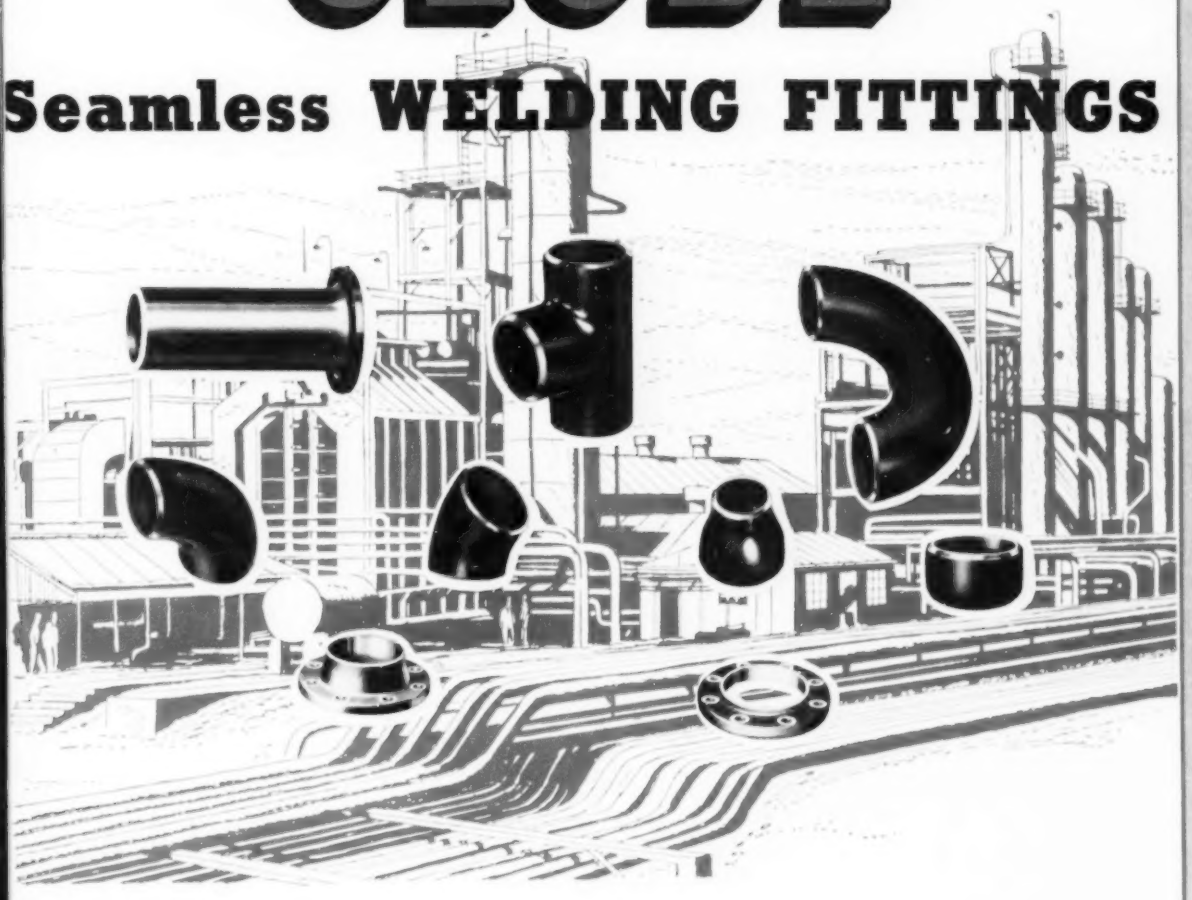
"Then we headed for the artists' colony at San Miguel Allende for more. It was fun exploring this city and meeting some American artists staying there, seeing the usual church in the town square, and poking around here and there. But, there were two flies in this ointment.

"The first was because the churches, during a fiesta we found in progress, insisted on having their bells rung every 30 minutes — beginning at 4 o'clock in the morning. This sounded like a boiler factory, for the schedules were unsynchronized. The second was that we hated to return to the daily afternoon rain in Mexico City (it was past the rainy season on the high plateau) but we feared that expense and salary checks would cease if we didn't start hitting the ball again."



GLOBE

Seamless WELDING FITTINGS



The only seamless welding fittings
precision-processed . . . from billet . . . to tube . . . to fitting

From charging the specially designed revolving furnace with a steel billet (above) through the many succeeding steps of production, every Globe process is specialized to produce fittings of unvarying quality.

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Because Globe has highly specialized controls—at every stage of manufacture at its own plant—you can be sure of uniform high quality seamless welding fittings when you specify Globe.

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Petrochemical Processing Section

STOPS CORROSION

It's worth checking into — one of the many Tygon Plastic formulations may be the answer to your tough corrosion problems.

LIQUID TYGON
quickly applied coating, as protection against corrosive fumes.

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Gaskets, grommets, diaphragms, molded mechanical items.

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Tubing, channel, special shapes, solid cord.

This dense, impermeable, 3/32" thick press-polished ***Tygon*** Sheet plastic shrugs off corrosives that quickly destroy rubber and other lining materials.

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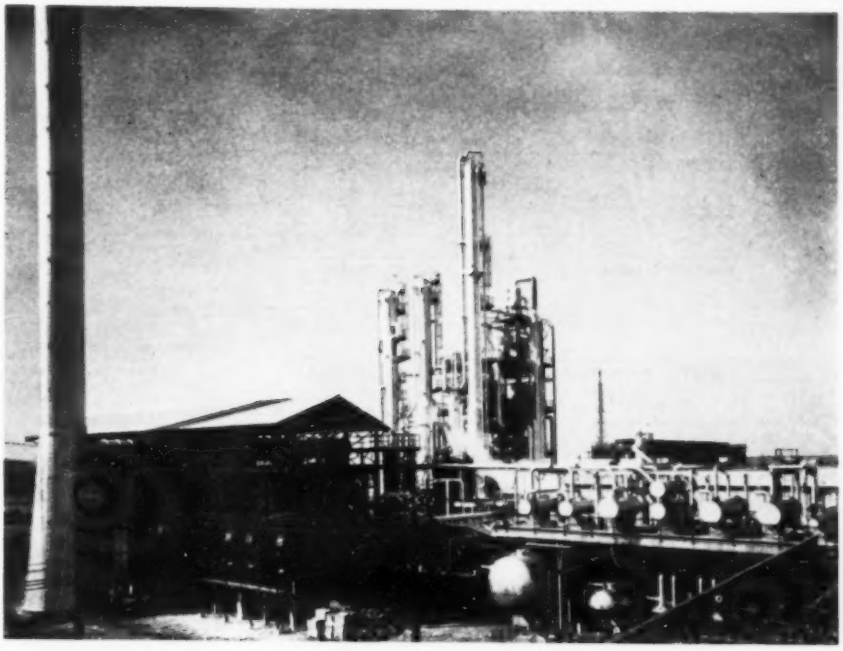
The next time you're faced with one of those "tough" lining jobs, talk to our engineers about ***Tygon.***

U. S. STONEWARE
Akron 9, Ohio

MANUFACTURERS AND FABRICATORS OF CORROSION RESISTANT MATERIALS AND EQUIPMENT SINCE 1865



AMONG THE NEWEST in the growing list of petrochemical plants is this ethylene unit, put on stream at Gulf Oil Corp.'s Pt. Arthur refinery Mar. 6. It is the world's largest—and will produce 2½ billion cu. ft. of the gas annually.

New 1953 Petrochemical Directory

Survey lists 143 firms in petrochemicals, with 271 plants operating, building or planned

OVER 60 new petrochemical plants are now in the planning or building stage in the United States and Canada, according to a survey of the industry just completed by the editors of PETROLEUM PROCESSING.

These facilities represent an investment of close to $750,000,000, and they do not include the other millions of dollars being spent to expand already existing petrochemical plants. The survey also showed that:

There are now 143 companies engaged in the manufacture of petrochemicals in the U. S. and Canada.

Of these, 58 are petroleum companies or petroleum company subsidiaries, 79 are chemical companies, and 6 are joint ventures between petroleum and chemical firms.

These companies between them have a total of 271 plants either in operation, under construction, or planned.

26 new plants have been put into operation in the past 12 months.

A new directory of petrochemical plants has been compiled, based on the PETROLEUM PROCESSING survey, and is published on the following 9 pages.

Since the last directory was published in the April 1952 issue of PETROLEUM PROCESSING, 37 additional companies and 90 more plants have been added to the list. Part of these increases, however, are accounted for by the fact that the new 1953 directory includes carbon black plants and Canadian petrochemical operations—neither of which were in the 1952 listing.

The editors of PETROLEUM PROCESSING make no claim that even this new listing is complete. New ventures in the petrochemical field are being announced practically every week. Even as this is being written, and after the following directory was set in type and made up, word had reached us that Spencer Chemical Co. has announced plans to build a new plant at Orange, Texas, to make polyethylene, using ethylene to be supplied by pipeline from Gulf's refinery at nearby Pt. Arthur. Also, Gulf has confirmed that it definitely is going ahead with plans to double the size of its new ethylene unit—put on stream only a few months ago.

The new directory, in addition to giving company names and plant locations, hydrocarbon raw materials and petrochemical products, this year also lists plant managers.

Petrochemical Plants in the United States

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Allied Chemical & Dye Corp. (Barrett Div.) Frankford, Pa.	petroleum fractions	phenol	J. P. Depman Mgr.	Under construction, completion expected May '53.
Allied Chemical & Dye Corp. (General Chemical Div.) El Segundo, Calif.	refinery gases (from Wilshire and Std. of Calif.)	sulfuric acid		
Allied Chemical & Dye Corp. (General Chemical Div.) Richmond, Calif.	refinery gases (from Std. of Calif.)	sulfuric acid		
Allied Chemical & Dye Corp. (National Aniline Div.) Buffalo, N. Y.	kerosine	synthetic detergents	C. C. Coakley Mgr.	
Allied Chemical & Dye Corp. (Nitrogen Div.) La Platte, Neb.	natural gas	urea and ammonia products		Under construction, completion scheduled for May '54.
Allied Chemical & Dye Corp. (Nitrogen Div.) South Point, Ohio	natural gas	ammonia, methanol, urea	S. G. McKenzie Gen. Supt.	Under construction, completion scheduled for May '53. Urea facilities scheduled for completion in early '54.
Allied Chemical & Dye Corp. (Nitrogen Div.) Orange, Texas	ethylene	ethylene glycol, ethylene oxide		Under construction, completion scheduled for Mar. '54. Ethylene from Gulf's Pt. Arthur plant.
Allied Chemical & Dye Corp. (Nitrogen Div.) Hopewell, Va.	natural gas	ammonia, methanol		New plant, was scheduled for completion Mar. '53.
Allied Chemical & Dye Corp. (Semet-Solvay Div.) Buffalo, N. Y.	petroleum fractions	long chain alcohol wax	H. G. Bringgs Mgr.	Under construction, completion scheduled for May '53. Benzene to be recovered as a by-product.
Alox Corp. Niagara Falls, N. Y.	petroleum fractions	rust preventives, engine oil additives	Arlie A. O'Kelly Tech. Dir.	
American Cyanamid Co. Parish of Jefferson, La.	natural gas	ammonia, acetylene, hydrocyanic acid, acrylonitrile	G. J. Forney	Under construction, scheduled for completion early '54. $7,500,000 DPA certificate announced 9/17/52 for urea.
American Petrochemical Corp. Lake Charles, La.	possibly refinery gases or petroleum fractions	ethylene, ethylene glycol, ethylene oxide, vinyl chloride, ethyl chloride		$26,640,000 DPA certificate, 5/29/52. Joint venture of Cities Service Refining Corp. and Firestone Tire & Rubber Co. No word from company on present status except "program in the formative stage".
Aromatics Refining Co. Baton Rouge, La.				$11,500,000 DPA certificate for benzene, toluene, xylene issued 5/3/51, but project abandoned. Subsidiary of Wood River Oil & Refining Co.
Atlantic Refining Co. Philadelphia, Pa.	natural gas, petroleum fractions, refinery gases	ammonia, synthetic detergents, sulfuric acid		
Atlantic Refining Co. Alreco, Texas	petroleum fractions	synthetic detergents		
Atlas Processing Co. Shreveport, La.	petroleum naphtha	benzene	V. B. Chance Pres.	
Barium Reduction Corp. S. Charleston, W. Va.	natural gas	carbon disulfide, hydrogen sulfide		
Belle Alkali Co. Belle, W. Va.	natural gas	methyl chloride, methylene chloride, chloroform		
Brea Chemicals, Inc. Brea, Calif.	natural gas	ammonia		Under construction, completion scheduled for mid-'54. Brea will lease from owner—Amonaico Corp. Brea is subsidiary of Union Oil Co. of Calif.
Bryton Chemical Co. Trainer, Pa.	petroleum fractions	oil-soluble sulfonates	E. W. Carlson	Subsidiary of Continental Oil Co.
Cabot Carbon Co. Bayou Sale, La.	petroleum residues, natural gas	oil and gas furnace blacks, thermal and metallurgical carbons	H. S. Ayres	
Cabot Carbon Co. Ville Platte, La.	petroleum residues, natural gas	oil and gas furnace blacks	R. T. Bowen	
Cabot Carbon Co. Hobbs, N. Mex.	natural gas	rubber channel blacks	H. M. Coday	
Cabot Carbon Co. Guymon, Okla.		carbon blacks		Closed down since 1952.
Cabot Carbon Co. Kermit, Texas	natural gas	rubber channel blacks	A. L. Dixon	
Cabot Carbon Co. Kingsmill, Texas		carbon blacks		Closed down since 1952.
Cabot Carbon Co. Skellytown, Texas	natural gas	rubber channel blacks, special ink and paint blacks	W. L. Marshall (Shafer "A" Plant); J. M. Brown (Shafer "B" Plant)	
Cabot Carbon Co. Stinnett, Texas		carbon blacks		Closed down since 1948.
Cabot Carbon Co. Wickett, Texas	natural gas	rubber channel blacks	G. S. Gray	
Cabot Carbon Co. (General Atlas Div.) Guymon, Okla.		carbon blacks		Closed down since 1952.
Cabot Carbon Co. (General Atlas Div.) Big Spring, Texas	petroleum residues	oil furnace blacks	A. R. Davenport	

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Cabot Carbon Co. (General Atlas Div.) Pampa, Texas	natural gas, petroleum residues	oil and gas furnace blacks	E. J. O'Brient	
Carbide and Carbon Chemicals Co. Torrance, Calif.	refinery gases	polyethylene, ethylene glycol		Division of Union Carbide and Carbon Corp. Under construction, completion scheduled for end of '54. Raw material from adjacent General Petroleum Corp. refinery.
Carbide and Carbon Chemicals Co. Whiting, Ind.	refinery gases	synthetic organic chemicals, including: ethylene glycol, isopropanol, acetic acid, acetic anhydride	W. J. Bagby	Division of Union Carbide and Carbon Corp.
Carbide and Carbon Chemicals Co. Marietta, Ohio	natural gas	styrene		Division of Union Carbide and Carbon Corp. Plant still in "proposed" stage, but $2,722,000 DPA certificate issued 7/16/52.
Carbide and Carbon Chemicals Co. Seadrift, Texas	natural gas	ethylene glycol, polyethylene	C. M. Blair, Jr.	Division of Union Carbide and Carbon Corp. Under construction, completion scheduled for mid-'54.
Carbide and Carbon Chemicals Co. Texas City, Texas	natural and refinery gases	synthetic organic chemicals and resins, including: alcohols, glycols, ethylene-amines, acetone, acetic acid and acetic anhydride, vinyl resins and polyethylene	E. J. Fox	Division of Union Carbide and Carbon Corp.
Carbide and Carbon Chemicals Co. Institute, W. Va.	natural gas	synthetic organic chemicals, including: ethanol, butanol, 2-ethylhexanol, glycols, acetic acid, acetic anhydride, maleic anhydride, styrene, polyethylene, glycols, plasticizers.	C. H. Atwood	Division of Union Carbide and Carbon Corp.
Carbide and Carbon Chemicals Co. S. Charleston, W. Va.	natural and refinery gases	synthetic organic chemicals and resins, including: alcohols, glycols, ethers and oxides, esters, ketones, aldehydes, acetals, anhydrides, wetting agents, plasticizers, etc.; vinyl resins and polyethylene.	D. B. Benedict	Division of Union Carbide and Carbon Corp.
Carlisle Chemicals Works, Inc. Reading, Ohio	petroleum fractions	cutting and lube oil additives.	W. R. Hawkins Supt.	Subsidiary of Cincinnati Milling Machine Co.
Carthage Hydrocol, Inc. Brownsville, Texas	natural gas	acetaldehyde, propionaldehyde, methanol, methyl ethyl ketone, ethanol, n-propanol, n-butanol, n-amyl alcohol, acetic acid, propionic and butyric acid, methyl propyl ketone	V. K. Brandenburg Supt.	Petrochemicals produced as by-products of synthetic liquid fuel plant. Piped to adjacent plant of Stanolind Oil & Gas Co. for separation and purification. Plant reported in partial operation since 1951.
Celanese Corp. of America Bishop, Texas	propane, butane	methanol, n-propanol, formaldehyde, paraformaldehyde, acetaldehyde, acetic acid, acetone, butylene glycol, propylene oxide and glycol, dipropylene glycol, trioxane	Ernest T. Lindsey	Additional facilities under construction.
Celanese Corp. of America Pampa, Texas	propane, butane	acetic acid, aldehyde, acetone, methanol and solvents.	J. F. Frick	Plant started operation Nov. '52. Additional facilities under construction for manufacture of vinyl acetate.
Chemstrand Corp. Decatur, Ala.	methane	acrylonitrile	F. William Koster Mgr., Acrilan plant Roy G. Hemminghaus Mgr., Chemstrand nylon plant	Jointly-owned associate company of American Viscose Corp. and Monsanto Chemical Co. Product acrylonitrile used for production of Acrilan acrylic fiber and Chemstrand nylon. Acrilan plant put into operation Aug. '52. Chemstrand nylon plant scheduled for completion 1st half '54.
Cities Service Oil Co. (Del.) Maud, Okla.	natural gas	methanol, acetaldehyde, formaldehyde, acetone		Plant shut down.
Cities Service Oil Co. (Del.) Oklahoma City, Okla.	natural gas	methanol, acetaldehyde, formaldehyde, acetone		Crude mixtures only, shipped to Tallant plant for purification.
Cities Service Oil Co. (Del.) Tallant, Okla.	natural gas	methanol, acetaldehyde, formaldehyde, acetone		
Cities Service Refining Corp. Lake Charles, La.	refinery gases	butadiene		Government-owned plant operated by Cities Service.
Coltexo Corp. Lefors, Texas	natural gas	carbon black		Owned Jointly by Columbian Carbon Co. and The Texas Co.
Columbia-Southern Chemical Corp. Barberton, Ohio	ethylene	perchlorethylene		Subsidiary of Pittsburgh Plate Glass Co.
Columbia-Southern Chemical Corp. Natrium, W. Va.	petroleum fractions	chlorinated benzenes		Subsidiary of Pittsburgh Plate Glass Co.
Columbian Carbon Co. El Dorado, Ark.	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Hickock, Kans.	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Eola, La.	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Eunice, N. Mex.	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Conroe, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Corpus Christi, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		

PLANT LOCATION COMPANY AND	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Columbian Carbon Co. Fortune, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Kingsmill, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Lefors, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Seagraves, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		
Columbian Carbon Co. Seminole, Texas	natural gas and/or petroleum fractions	sulfur, furnace and channel blacks		Sulfur recovery unit now under construction.
Columbian Carbon Co. Sunray, Texas	natural gas and/or petroleum fractions	furnace and channel blacks		
Commercial Solvents Corp. Peoria, Ill.	natural gas (propane)	nitroparaffins	T. M. Walton	
Commercial Solvents Corp. Sterlington, La.	natural gas	methanol, ammonia, ammonium nitrate, methylamines	J. E. Wheeler	Methylamines facilities under construction, completion expected by mid-'53.
Consolidated Chemical Industries, Inc. Baton Rouge, La.	refinery gases	sulfuric acid		Uses gases from nearby Esso Standard Oil Co. refinery.
Consolidated Chemical Industries, Inc. Baytown, Texas	refinery gas and acid sludge	sulfur, sulfuric acid		Sulfur recovery unit under construction, completion scheduled for late '53. Acid unit completion expected late '54. Will use gases and sludge from adjacent refinery of Humble Oil and Refining Co.
Consumers Cooperative Assn. See—Cooperative Farm Chemicals Assn.				
Continental Carbon Co. Sunray, Texas	natural gas, refractory cycle stock	carbon blacks (including fast extruding furnace type, and semi-reinforcing)		
Continental Oil Black Co. Westlake, La.	refractory cycle stock	HAF carbon black	Raymond Reinke	
Continental Oil Black Co. (location not determined)		HAF carbon black		Project now in planning stage, total estimated cost $2,700,000. Originally slated for Hobbs N. Mex., but new location being studied.
Continental Oil Co. Chicago, Ill.	dodecylbenzene	water soluble sulfonates	P. E. Geiser	Formerly Stepan Chemical Co.
Continental Oil Co. Lake Charles, La.	petroleum fractions	benzene, toluene	J. M. Jones	Under construction, completion expected in fall of '53.
Continental Oil Co. Baltimore, Md.	benzene, propylene tetramer	synthetic detergent base stock	J. C. Hough	
Continental Oil Co. Ponca City, Okla.	petroleum fractions	benzene, toluene; lube oil additives	H. R. Wall	Aromatics facilities in operation; additive plant under construction, with completion scheduled for spring of '54.
Cooperative Farm Chemicals Assn. Lawrence, Kans.	natural gas	anhydrous ammonia, ammonium nitrate	J. M. Wadsworth Supt.	Under construction, completion scheduled for Aug. '54.
Copolymer Corp. Baton Rouge, La.	butylene, styrene	butadiene, GR-S synthetic rubber		Government-owned plant, operated by Copolymer Corp., a company jointly owned by Armstrong Rubber Co., Armstrong Rubber Manufacturing Co., Dayton Rubber Co., Gates Rubber Co., Lee Rubber and Tire Co., Mansfield Tire and Rubber Corp., Sears, Roebuck & Co., and Seiberling Rubber Co.
Cosden Petroleum Corp. Big Spring, Texas	mercaptans from extraction, olefins and hydrogen sulfide, acid oils	aryl mercaptans, phenols, cresols	W. K. Jackson Dir., Organic Chem. Div.	
Cosden Petroleum Corp. Big Spring, Texas	petroleum fractions	nitration grade benzene, toluene, xylene	Geo. Grimes Supt.	New plant put into operation Aug. 29, 1952.
Deep Rock Oil Corp. Cushing, Okla.	petroleum fractions	benzene, toluene, xylene		$3,400,000 DPA certificate, 11/5/51, but project now temporarily suspended.
Deere & Company (Grand River Chemical Div.) Pryor, Okla.	natural gas	nitrogenous fertilizer products	L. A. Rowland V.P. and Gen. Mgr. W. W. Grandle Wks. Mgr.	Under construction completion expected in spring of '54.
Delta Gas Chemical Corp. Buras, La.	natural gas	nitrogenous fertilizers		$8,892,000 DPA certificate, 3/31/52, but no word from company as to present status of project.
Dewey and Almy Chemical Co. Cambridge, Mass.		synthetic rubber specialties		
Diamond Alkali Co. Houston, Texas	refinery and natural gas	methyl chloride, methylene chloride, ethylene dichloride, vinyl chloride, percholorethylene, trichlorethylene, chloroform	C. E. Lyon	Part of units now in operation, completion of balance expected by July '53.
Diamond Alkali Co. (Undecided)	refinery gases	perchlorethylene		$1,070,000 DPA certificate, 10/8/52; location of project not yet decided.
Dow Chemical Co. Gardena, Calif.	ethylene (propane), benzene	styrene, ethylbenzene		
Dow Chemical Co. Pittsburg, Calif.	natural gas	methylene chloride, methyl chloride, chloroform, carbon tetrachloride, perchlorethylene		

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Dow Chemical Co. Torrance, Calif.	ethylene, benzene	styrene		Government-owned plant, operated by Dow.
Dow Chemical Co. Midland, Mich.	ethylene, propylene (crude oil, natural gas)	styrene, butadiene, methyl styrene, ethylene glycol, ethylbenzene, ethyl chloride, ethylene dibromide, diethyl benzene, divinyl benzene, ethylene dichloride, dichloroethyl ether, ethylene oxide, mono-, di-, triethanolamine, ethylene diamine, i-propyl benzene, i-propyl chloride, propylene dichloride, propylene glycol, propylene oxide., i-propanolamines, vinyl chloride, polyglycols, polyglycol ethers, polyvinylidene chloride		Additional facilities under construction.
Dow Chemical Co. Freeport and Velasco, Texas	methane (natural gas), ethylene and propylene (cracking of ethane-propane mixtures), benzene	styrene, methyl chloride, ethyl chloride, ethylene dichloride, vinyl chloride, carbon tetrachloride, chloroform, hexachlorethane, ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, perchlorethylene, trichlorethylene, dichlorethyl ether, dichlorisopropyl ether, ethylene oxide, propylene oxide, polyglycol ethers, polyvinylidene chloride, polyethylene		Additional facilities under construction.
du Pont, E. I., de Nemours & Co. La Porte, Texas	benzene	benzene hexachloride		
du Pont, E. I., de Nemours & Co. Orange, Texas	natural gas, propane, ethylene, benzene, cyclohexane	nylon intermediates (adipic acid, hexamethylene diamine), methanol, polyethylene	D. B. Campbell Mgr.	
du Pont, E. I., de Nemours & Co. Victoria, Texas	natural gas, butadiene	adiponitrile	R. L. Schulyer Mgr.	
du Pont, E. I., de Nemours & Co. Belle, W. Va.	benzene, cyclohexane	nylon intermediates (adipic acid, hexamethylene diamine), ketone alcohol mixture	F. A. Otto Mgr.	
Eastern States Chemical Corp. Houston, Texas	petroleum fraction	benzene and aromatic solvents	D. D. Henson	Subsidiary of Eastern States Petroleum Co.
Esso Standard Oil Co. Baton Rouge, La.	refinery and natural gases, petroleum fractions	i-propyl alcohol, ethyl alcohol, i-octyl alcohol, ethyl ether, i-propyl ether, di-isobutylene, butadiene, isoprene, dicyclopentadiene, benzene, toluene, butyl rubber	H. J. Voorhies Gen. Mgr.	Butyl rubber plant is government-owned, but operated by Esso.
Esso Standard Oil Co. Linden, N. J.	refinery gases	i-propyl alcohol, s-butyl alcohol, i-propyl acetate, s-butyl acetate, methyl ethyl ketone, i-propyl ether, naphthenic acids, lube oil additives, sulfuric acid	Daniel L. Hussey Gen. Supt.	
Ethyl Corp. Baton Rouge, La.	ethane, ethylene, propane, benzene	ethyl chloride, ethylene dibromide, tetraethyl lead, benzene hexachloride, lindane	Roy N. Clothier	
Ethyl Corp. Houston, Texas	ethylene	ethyl chloride, ethylene dichloride, tetraethyl lead	Wallace F. Armstrong	New Plant, put into operation May '52.
Ethyl-Dow Corp. Freeport, Texas	ethylene	ethylene dibromide	V. A. Thorpe	Subsidiary of Ethyl Corp. and Dow Chemical Co.
Firestone Tire & Rubber Co. Lake Charles, La.	butadiene, styrene	GR-S synthetic rubber		Government-owned plant, operated by Firestone.
Firestone Tire & Rubber Co. Akron, Ohio	butadiene, styrene	GR-S synthetic rubber		Government-owned plant, operated by Firestone.
Freeport Sulphur Co. Westville, N. J.	refinery gases	sulfur		Uses gases from The Texas Co. refinery at Westville, N. J.
Food Machinery and Chemical Corp. (Westvaco Chemical Div.) S. Charleston, W. Va.	natural gas	carbon disulfide		Plant reported under construction.
Foster Grant Co. Pt. Arthur, Texas	(undisclosed)	styrene		$4,860,000 DPA certificate, 7/7/52. Company has not released any further details.
General Atlas Carbon Co.				see Cabot Carbon Co. (General Atlas Div.)
General Petroleum Corp. Torrance, Calif.	refinery wastes	ammonium sulfate	A. E. Thompson Mgr.	
General Petroleum Corp. Worland, Wyo.	natural gas	sulfur		Under construction.
General Tire & Rubber Co. Baytown, Texas	butadiene, styrene	GR-S synthetic rubber	T. Lyman Gen. Mgr.	Government-owned plant, operated by General.
Globe Oil & Refining Co. Lemont, Ill.	refinery gases	sulfur		$182,890 DPA certificate, 7/2/52.
Goodrich, B. F., Chemical Co. Louisville, Ky.	butadiene, styrene acrylonitrile	nitrile type synthetic rubber	John L. Nelson	
Goodrich, B. F., Chemical Co. Akron, Ohio	butadiene, styrene acrylonitrile	nitrile type synthetic rubbers	Fred C. Hands	
Goodrich, B. F., Chemical Co. Port Neches, Texas	butadiene, styrene	GR-S synthetic rubber	Walter R. Bateman Acting Mgr.	Government-owned plant, operated by Goodrich.
Goodrich, B. F., Chemical Co. Institute, W. Va.	butadiene, styrene	GR-S synthetic rubber	Anton Vittone	Government-owned plant, operated by Goodrich.
Goodrich-Gulf Chemicals, Inc. Orange, Texas				Joint operation, in planning stage, of Gulf Oil Corp. and B. F. Goodrich Co. Site only at Orange; operations office in Pittsburgh, Pa.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Goodyear Synthetic Rubber Corp. Akron, Ohio	butadiene, styrene	GR-S synthetic rubber	R. C. Stell	Government-owned plant, operated by Goodyear.
Goodyear Synthetic Rubber Corp. Houston, Texas	butadiene, styrene	GR-S synthetic rubber	B. A. Rosinski	Government-owned plant, operated by Goodyear.
Goodyear Tire & Rubber Co. Akron, Ohio		high styrene resins, nitrile type synthetic rubber		$1,762,000 DPA certificate, 7/16/52, for high styrene resin facilities; now under construction, completion scheduled for Sept. '53.
Grace Chemical Co. Woodstock, Tenn.	natural gas	anhydrous ammonia, urea	John G. Carriere	Subsidiary of W. R. Grace & Co. Under construction, completion scheduled for July '54.
Great Southern Chemical Co. Corpus Christi, Texas	butane, petroleum fractions	butylene, butadiene, benzene, toluene, xylene	M. T. McCants	Aromatics facilities under construction, completion scheduled for Sept. '53. Company is owned by Chicago Corp., Gulf Oil Corp., LaGloria Corp. and Pontiac Refining Corp.
Griffin Chemical Co. Richmond, Calif	crude petroleum sulfonates, naphthenates	naphthenic acid, lube oil additives	W. P. Ruedrich	
Gulf Oil Corp. Philadelphia, Pa.	refinery gases	propylene, sulfur	J. O. Timms	Sulfur recovery unit in planning stage; $1,130,000 DPA certificate 10/29/52.
Gulf Oil Corp. Pt. Arthur, Texas	refinery gases, heptene	ethylene, sulfur, isooctyl alcohol	R. C. Faulkner	Sulfur recovery unit completed Dec. '52. Isooctyl alcohol and ethylene units completed Feb. 15, '53. Expansion of ethylene unit under consideration.
Gulf Oil Corp. Waddell plant (near Crane, Texas)	natural gas	sulfur	T. W. Rhoads	New plant, in operation June 11, 1952.
Hancock Chemical Co. Long Beach, Calif.	refinery gases	sulfur	Hugh J. Gribben	Uses gases from refineries of Hancock, Richfield, Texaco and General Petroleum.
Hancock Oil Co. Long Beach, Calif.	refinery gases	ethylene glycol		In planning stage; $4,000,000 DPA certificate, 6/15/51.
Hercules Powder Co. Hercules, Calif.	natural gas (methane)	anhydrous ammonia		
Hercules Powder Co. Delaware River area (near Gibbstown, N. J.)	cumene from benzene and propylene	phenol, acetone, p-cresol, cymene alcohol, flotation reagents		Under construction, completion expected early '54.
Heyden Chemical Corp. Texas City, Texas				See listing of joint Monsanto-Heyden plant under Monsanto Chemical Co.
Hooker Electrochemical Co. Niagara Falls, N. Y.	benzene, toluene, pentane, wax	various chlorbenzenes, chlortoluenes and their derivatives, hexachlorocyclopentadiene and chlorinated waxes	H. B. Young Wks. Mgr.	
Huber, J. M., Corp. Borger, Texas	natural gas	carbon black		
Huber, J. M., Corp. Eldon, Texas	oil	carbon black	Max Nuttall	
Humble Oil & Refining Co. Baytown, Texas	refinery gases and petroleum fractions	butadiene, cyclohexane, toluene, xylene, aromatic solvents, aliphatic solvents, paraxylene, butyl rubber		Butadiene and butyl rubber plants are government-owned, but operated by Humble. Paraxylene plant under construction, scheduled for completion in May '53.
Hyman, Julius, and Co. Denver, Colo.	petroleum fractions	aldrin, dieldrin, specialty chemicals	J. G. Bejarano	Division of Shell Chemical Corp.
Imperial Sulphur & Acid Co. Farmington, N. Mex.	natural gas	sulfur		Under construction.
Jefferson Chemical Co. Pt. Neches, Texas	refinery gases	ethylene glycol, diethylene glycol, ethylene oxide, ethylene dichloride, mono-, di-, and tri ethanolamine, nonyl phenol, aromatic distillate	Lynn R. Strawn	Owned jointly by American Cyanamid Co. and The Texas Co.
Kendall Refining Co. Bradford, Pa.	petroleum fractions	information not made available		
Kentucky Synthetic Rubber Corp. Louisville, Ky.	butadiene, styrene	GR-S synthetic rubber	H. R. Erwin Pl. Mgr.	Government-owned plant, operated by Kentucky Syn. Rub. Corp., a company owned by 10 non-tire rubber companies: American Hard Rubber Co., Boston Woven Hose & Rubber Co., Brown Rubber Co., Inc., Hewitt-Robbins, Inc., Goodall Rubber Products Co., Sponge Rubber Products Co., Sheller Manufacturing Corp., Simplex Wire & Cable Co., Thiokol Corp., and Raybestos-Manhattan, Inc.
Koppers Co., Inc., (Chemical Div.) Kobuta Plant Monaca, Pa.	ethylene	styrene monomer, polystyrene	B. R. Sarchet Mgr.	
Koppers Co., Inc. (Chemical Div.) Oil City, Pa.	petroleum fractions	alkylated phenols and cresols	C. G. Youngquist Mgr.	
Koppers Co., Inc. (Chemical Div.) Williams Plant Pt. Arthur, Texas	ethylene	ethylbenzene	H. E. Roche Mgr.	New plant, put in operation Nov. '52.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Lion Oil Co. El Dorado, Ark.	natural gas	sulfur, ammonia, ammonium sulfate, ammonium nitrate		
Lion Oil Co. Barton Plant Luling, La.	natural gas	ammonia, nitric acid, ammonium nitrate		Under construction, completion scheduled for early '54. $30,452,000 DPA certificate, 9/10/51 (originally intended for Charlotte, N. C., shifted to Luling, La.)
Lubrizol Corp. Cleveland, Ohio	petroleum fractions	lube oil additives		
Lubrizol Corp. Houston, Texas	petroleum fractions	lube oil additives		
Magnolia Petroleum Co. Beaumont, Texas	petroleum fractions	organic solvents	J. W. Newton V.P. and Mgr.	
Marbon Corp. Gary, Ind.	styrene, butadiene	high styrene resins	R. Shattuck Mgr.	
Mathieson Chemical Corp. Magnolia, Ark.	natural gas	sulfur		
Mathieson Chemical Corp. McKamie, Ark.	natural gas	sulfur		
Mathieson Chemical Corp. Brandenburg, Doe Run, Ky.	ethane (natural gas)	ethylene oxide, ethylene glycol, diethylene glycol, ethylene dichloride		
Mathieson Chemical Corp. Lake Charles, La.	natural gas	anhydrous ammonia	J. E. Baker	
Mathieson Mississippi Co. St. Louis, Mo. area	natural gas	possibly acetylene		New company, formed this year by Mathieson Chemical Corp. and Mississippi River Fuel Corp. No further information available.
McCarthy Chemical Co.				See Texas Gas Corp.
Merichem Co. Houston, Texas	petroleum fractions	cresylic acid, phenol-cresol blends, sodium sulfide, sodium sulhydrate	John T. Files V. Pres.	
Midland Rubber Co. Torrance, Calif.	butadiene, styrene	GR-S synthetic rubber		Government-owned plant, operated by Midland, a subsidiary of Minnesota Mining & Manufacturing Co.
Mississippi Chemical Corp. Yazoo City, Miss.	natural gas	ammonia, nitric acid, ammonium nitrate	W. B. Dunwoody, Gen. Operations Mgr.	Expansion now in progress, completion scheduled for spring of '54.
Monsanto Chemical Co. Avon, Calif.	undisclosed	phenol	Irving C. Smith	Under construction, completion scheduled for early '54.
Monsanto Chemical Co. Avon, Calif.	refinery gases and acid sludge	sulfuric acid	Irving C. Smith	Joint operation with Tide Water Associated Oil Co., put into operation in Mar. '53.
Monsanto Chemical Co. Texas City, Texas	benzene, ethylene, methane	styrene, vinyl chloride, acrylonitrile	J. R. Mares	Methane converted to acetylene, intermediate for vinyl chloride and acrylonitrile.
Monsanto Chemical Co. Texas City, Texas	by-product gases from acetylene unit in adjacent Monsanto plant.	methanol		Joint operation of Monsanto Chemical Co. and Heyden Chemical Corp., now under construction. Apparently replaces methanol-from-natural gas plant Heyden previously planned to build at Houston.
Morton-Withers Chemical Co. Greensboro, N. C.	petroleum fractions	petroleum sulfonates, synthetic lubes, lube oil additives	John P. Withers V.P. of Prod. and Res.	Expansion of facilities now under way, completion scheduled for this year.
National Petro-Chemicals Co. Tuscola, Ill.	natural gas	ethanol, ethyl chloride	D. J. Stark Supt.	Owned by National Distillers Products Corp. (60%) and Panhandle Eastern Pipeline Co. Plant now in partial operation, balance due for completion in July '53.
Natural Gas Odorizing Co. Houston, Texas	petroleum fractions	gas odorants	Jeannette H. Gill	
Neches Butane Products Co. Pt. Neches, Texas	butylene	butadiene		Government-owned plant, operated by Neches Butane Products Co., a joint venture of Atlantic Refining Co., Pure Oil Co., Gulf Oil Corp. and The Texas Co.
Neville Co. Anaheim, Calif.	petroleum fractions	hydrocarbon resins, aromatic solvents	R. L. Ulrich West Coast Mgr.	
Neville Co. Neville Island Pittsburgh, Pa.	petroleum fractions	hydrocarbon resins, aromatic solvents		
Nimol Laboratories Chicago, Ill.	alkanes	specialty sulfonates	Jerome Kritchevsky	New plant, completion scheduled for late '53.
Old Dutch Refining Co. Muskegon, Mich.	petroleum fractions	aromatic concentrate	E. F. Sondregger	
Oronite Chemical Co. Oak Point, La.	petroleum fractions	lube oil additives	T. I. Clausen	Subsidiary of Standard Oil Co. of Calif.
Pacific Chemical Co. Franklin County, Wash.				$5,735,000 DPA certificate, 3/31/52; no word from company as to present status.
Pan American Refining Co. Texas City, Texas	petroleum fractions	hydrocarbon plasticizers, polymers and resins; aromatic solvents; benzene, toluene, xylene	Dr. H. R. Snow	
Pan-Am Southern Corp. El Dorado, Ark.	propane, propylene, butane, butylene	propylene tetramer, polybutene	E. N. Kimes Mgr.	Unit for producing tetramer (high molecular weight polymer of propylene) put into operation in Nov. '52.
Pathfinder Chemical Corp. Point Pleasant, W. Va.		styrene		$11,496,320 DPA certificate, 7/10/52. No action taken yet. Subsidiary of Goodyear Tire & Rubber Co.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Pennsylvania Industrial Chemical Corp. Chester, Pa.	crude oil	butadiene, naphthalene, ethylbenzene, benzene, ethylene, isoprene, dicyclopentadiene, piperlene, isopropyl benzene	B. F. Schwelm Mgr. J. D. Vermeychuk Supt.	New plant, started in partial operation June '52.
Pennsylvania Industrial Chemical Corp. Jefferson, Pa.	ethylbenzene, ethylene bottoms	styrene, petroleum re ins	E. A. Taylor	New plant, partial completion scheduled for June '53, full completion for summer '54.
Phillips Chemical Co. Borger, Texas	butane, styrene	butylenes, propylenes, butadiene, GR-S synthetic rubber	A. B. Leonard	Plant is government-owned operated by Phillips.
Phillips Chemical Co. Borger, Texas	liquid hydrocarbons	carbon blacks (FEF, HAF, SAF)	A. J. Head	
Phillips Chemical Co. Crane, Texas	natural gas	sulfur	A. F. Legatski	Put into operation Aug. '52.
Phillips Chemical Co. Etter, Texas	natural gas	ammonia, ammonium nitrate and nitrogen solutions	C. W. Forman	Ammonia plant is government-owned, leased and operated by Phillips. Nitrate and nitrogen solutions facilities are Phillips-owned.
Phillips Chemical Co. Goldsmith, Texas	natural gas	sulfur	A. F. Legatski	Put into operation Feb. '52.
Phillips Chemical Co. Houston, Texas	natural gas, acetaldehyde	ammonia, ammonium sulfate, methylvinylpyridine	R. G. Rhodes	Ammonium sulfate facilities being expanded, for completion in Dec. '53. Methylvinylpyridine facilities put into operation Dec. '52.
Phillips Chemical Co. Houston, Texas	natural gas	anhydrous ammonia		New plant, completion scheduled for Nov. '53.
Productol Co. Santa Fe Springs, Calif.	petroleum fractions	phenols, cresols, cresylic acids, naphthalene	E. E. Chipman	
Pure Oil Co. Toledo, Ohio	petroleum fractions	toluene, xylene, aromatic fractions		
Pure Oil Co. (Smiths Bluff Refinery) Nederland, Texas	petroleum fractions	lube oil additives		
Purex Corp. South Gate, Calif.	propylene	sulfonated alkyl benzene		New plant, in operation in '52.
Purex Corp. St. Louis, Mo.	propylene	sulfoniated alkyl benzene		
Republic Oil Refining Co. Texas City, Texas	petroleum fractions	benzene, toluene, xylene	L. W. Robbie V.P. and Gen. Mgr.	Under construction, completion scheduled for Aug. '53.
Richfield Oil Corp. (Watson Refinery) Los Angeles, Calif.	refinery gases	ethylene	C. R. McKay	Under construction, completion scheduled for Aug. '54.
Rohm and Haas Co. Houston, Texas	natural gas	hydrogen cyanide for methacrylate manufacture and chemical intermediate; carbon monoxide for acrylate manufacture	V. C. Henrich	
Rooseveit Oil and Refining Corp. Mt. Pleasant, Mich.	petroleum fractions	benzene, toluene	T. J. Williams	New plant, put in operation Jan. '53.
San Jacinto Chemical Corp.	natural gas	ammonia	D. A. White	$900,000 DPA certificate, 3/31/52 for expansion; no word from company as to present status.
Shamrock Oil and Gas Corp. Sunray, Texas	natural gas	sulfur	A. V. Beckworth Supt.	
Sharples Chemicals Inc. Wyandotte, Mich.	pentane, triisobutylene	amyl alcohol, amyl chloride, amyl acetate, amyl phenols, amyl naphthalenes, amyl mercaptan, tert-dodecylmercaptan, polyethylene glycol tert-dodecylthioether	H. F. Bjork	
Shell Chemical Corp. Dominquez, Calif.	refinery gases	alcohols, solvents, and other organic chemicals	Glenn Purcell	
Shell Chemical Corp. Martinez, Calif.	refinery gases	alcohols, solvents, and other organic chemicals	F. E. Caddy	
Shell Chemical Corp. Pittsburg, Calif.	natural gas	ammonia, ammonium sulfate, carbon black, catalysts	E. S. Bodine	
Shell Chemical Corp. Torrance, Calif.	butylene	butadiene	M. Voogd	Government-owned plant, operated by Shell.
Shell Chemical Corp. Ventura, Calif.	natural gas	ammonia	F. D. Kuenzly	Under construction, scheduled for completion in '53.
Shell Chemical Co. Norco, La.	undisclosed	isopropyl alcohol		$6,900,000 DPA certificate, 4/2/53; no further details available.
Shell Chemical Co. Houston, Texas	refinery gases	alcohols, solvents, and other organic chemicals, sulfur	B. M. Downey	
Shell Oil Co. Martinez, Calif.	petroleum fractions	petroleum sulfonates	J. A. Tench	New unit, put into operation Dec. '52.
Shell Oil Co. Dominquez Refinery Wilmington, Calif.	petroleum fractions	benzene, toluene, xylene	R. W. McOmie	New unit, put into operation Mar. '53.
Shell Oil Co. Wood River, Ill.	petroleum fractions	toluene, xylene	H. D. Dale	Under construction, scheduled for completion June '53.
Shell Oil Co. Houston, Texas	petroleum fractions	benzene, toluene	M. P. L. Love	New unit, put into operation Feb. '53.
Sid Richardson Carbon Co. Odessa, Texas	natural gas	sulfur		Owned jointly by Sid Richardson and Odessa Natural Gasoline Co.; operated by Odessa.
Sid Richardson Carbon Co. Odessa, Texas	natural gas	carbon blacks (channel)	H. H. Offutt	
Sid Richardson Gasoline Co. Pointe-ala-Hache, La.		nitrogenous fertilizers		$19,000,000 DPA certificate 3/31/52; project abandoned.
Sid Richardson Gasoline Co. Kermit, Texas	natural gas	sulfur		
Sinclair Refining Co. East Chicago, Ill.	petroleum fractions	lube oil additives		Manufacture of cresylic acids discontinued in '52.

COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
Sinclair Refining Co. Sand Springs, Okla.	petroleum fractions	demulsifying agents		
Sinclair Refining Co. Marcus Hook, Pa.	refinery gases	sulfur, propylene tetramer, cresylic acids		Sulfur recovery unit in operation Dec. '52.
Sinclair Refining Co. Houston, Texas	petroleum fractions	sulfonates		
Sinclair Rubber, Inc. Houston, Texas	butanes, butylenes	butadiene		Government-owned plant operated by Sinclair Rubber.
Socony-Vacuum Oil Co. Paulsboro, N. J.	petroleum fractions	benzonitrile		
Sonneborn, L., Sons, Inc. Petrolia, Pa.	petroleum fractions	petroleum sulfonates		
Spencer Chemical Co. (Jayhawk Works) Pittsburg, Kans.	natural gas	anhydrous ammonia, methanol, ammoniating solutions, ammonium nitrate, nitric acid, carbon dioxide	V. F. Hobart	
Spencer Chemical Co. (Henderson Works) Henderson, Ky.)	natural gas	anhydrous ammonia	W. A. Johnston	
Spencer Chemical Co. (Vicksburg Works) Vicksburg, Miss.	natural gas	anhydrous ammonia and ammoniating solutions	F. L. Pyle	Under construction, completion scheduled for late '53.
Standard Oil Co. of Calif. El Segundo, Calif.	petroleum fractions, propylene	benzene, toluene, cumene		Aromatics unit in operation Dec. '52; cumene unit to be started this year, will supply feed stock for phenol plant company is building at Richmond, Calif.
Standard Oil Co. of Calif. El Segundo, Calif.	butane	crude butadiene		Government-owned plant, operated by Standard of Calif. Crude butadiene is finished at butadiene plant operated by Shell Chemical Co. at Torrance, Calif.
Standard Oil Co. of Calif. Richmond, Calif.	refinery gases and petroleum fractions	lube oil additives, cresylic acid, synthetic detergents, phthalic anhydride, benzene and toluene, phenol and acetone		Phenol and acetone units under construction, scheduled for completion in late '54; will use cumene from El Segundo refinery as raw material.
Standard Oil Co. (Ind.) Wood River, Ill.	refinery gases and petroleum fractions	iso-octyl alcohol, cumene, lube oil additives	Dr. G. F. Ordeman Mgr.	Alcohol unit scheduled for completion June '53; cumene unit in planning stage (scheduled for late '53); additive unit was scheduled for completion in Apr. '53.
Standard Oil Co. (Ind.) Whiting, Ind.	refinery gases and petroleum fractions	benzene, sulfur, alkymer	A. F. Endres Mgr.	Sulfur recovery unit in operation Aug. '52; alkymer unit in Feb. '53.
Standard Oil Co. (Ind.) Sugar Creek, Mo.	petroleum fraction	C_7 olefin concentrate	H. R. Boehmer	New unit, in operation Jan. '53.
Stanolind Oil and Gas Co. Brownsville, Texas	hydrocarbon synthesis chemical co-product stream	acetaldehyde, propionaldehyde, ethanol, n-propanol, n-butanol, acetone, methyl ethyl ketone, acetic acid, propionic acid	L. L. Smith Supt.	Mixed product stream comes from adjacent synthesis plant of Carthage Hydrocol.
Stanolind Oil and Gas Co. N. Cowden, Texas	natural gas	sulfur	E. R. Wagner Supt.	Was scheduled for completion Mar. '53.
Stanolind Oil and Gas Co. Sundown, Texas	natural gas	sulfur	H. S. Jones	New plant, in operation Aug. '52
Stanolind Oil and Gas Co. Elk Basin field, Wyo.	natural gas	sulfur	C. W. Ward Supt.	
Stauffer Chemical Co. Louisville, Ky.	propane-propylene	carbon tetrachloride perchlorethylene		Under construction, scheduled for completion Sept. '53.
Stephan Chemical Co. Chicago, Ill.				Now owned and operated by Continental Oil Co.; see listing under that name.
Sun Oil Co. Marcus Hook, Pa.	petroleum fractions	benzene, toluene, xylene, petroleum sulfonates, naphthenic acids	Charles E. Maschal	New units; aromatics unit scheduled for completion Dec. '53; other units were scheduled for completion in Feb. '53.
Sunray Oil Corp. Duncan, Okla.	petroleum fractions	propylene tetramer		Information not verified by company.
Suntide Refining Co. Corpus Christi, Texas	petroleum fractions	propylene tetramer	F. L. Martin Pres.	New plant, scheduled for completion late '53.
Taylor Oil and Gas Co. Corpus Christi, Texas	petroleum fractions	benzene, toluene	Fred P. Sewell	New plant, scheduled for completion Aug. '53. Previously known as Taylor Refining Co.
Texas Eastman Co. Harrison, Texas	undisclosed	polyethylene, synthetic hard wax		$10,800,000 DPA certificate, June '52; no further information available.
Texas Eastman Co. Longview, Texas	natural gas, ethane and propane	n-butyraldehyde, isobutyraldehyde, ethanol, and chemical intermediates	D. C. Hull V. Pres., Mgr.	New plant, put in operation last year; supplies products as raw materials for Kingsport, Tenn. plant of Eastman Tennessee Eastman Co. Both firms are divisions of Eastman Kodak Co.
Texas Gas Corp. Winne, Texas	natural gas	methanol, acetaldehyde, formaldehyde		Petrochemical plant not in operation; formerly McCarthy Chemical Co.
Texas Gulf Sulphur Co. Worland, Wyo.	natural gas	sulfur		
Thermatomic Carbon Co. Sterlington, La.	natural gas	carbon black	R. W. Cretney Mgr.	
Union Oil Co. of Calif. Wilmington, Calif.	refinery gases, refinery wastes	methyl and ethyl mercaptans, sulfur, ammonium sulfate		See also Brea Chemicals, Inc. $12,000,000 DPA certificate issued 5/15/52 for benzene and toluene.
United Carbon Co. Franklin, La.	natural gas and oil	furnace carbon blacks	Wayne Herkness (Charleston, W. Va.)	

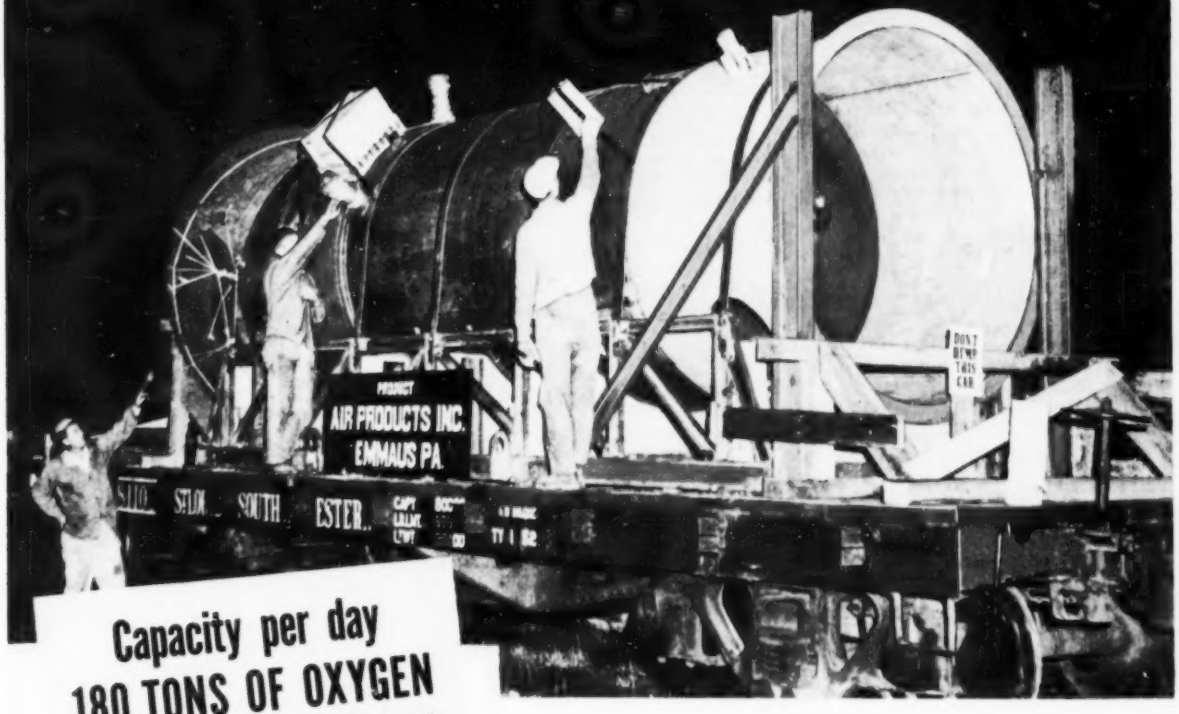
COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
United Carbon Co. Rayville, La.	natural gas	channel carbon black	C. E. McKinney (Borger, Texas)	
United Carbon Co. Swartz, La.	natural gas	channel carbon black	C. E. McKinney (Borger, Texas)	
United Carbon Co. Eunice, N. Mex.	natural gas	channel carbon black	C. E. McKinney (Borger, Texas)	
United Carbon Co. Aransas Pass, Texas	natural gas and oil	furnace carbon blacks	Wayne Herkness (Charleston, W. Va.)	
United Carbon Co. Aransas Pass, Texas	natural gas	channel carbon black	C. E. McKinney (Borger, Texas)	
United Carbon Co. Borger, Texas	natural gas	channel carbon black	C. E. McKinney	
United Carbon Co. Falfurrias, Texas	natural gas	channel carbon black	C. E. McKinney (Borger, Texas)	
United Carbon Co. Ryus, Kans.	natural gas and oil	furnace carbon blacks	Wayne Herkness (Charleston, W. Va.)	
United Carbon Co. Shamrock, Texas	natural gas and oil	furnace carbon blacks	Wayne Herkness (Charleston, W. Va.)	
U. S. Rubber Co. Naugatuck, Conn.	butadiene, styrene	GR-S synthetic rubber		Government-owned plant, operated by U. S. Rubber.
U. S. Rubber Co. Joliet, Ill.		undisclosed		Information restricted under government security regulations.
U. S. Rubber Co. (Naugatuck Chemical Div.) Baton Rouge, La.		nitrile type synthetic rubbers		
U. S. Rubber Co. Port Neches, Texas	butadiene, styrene	GR-S synthetic rubber		Government-owned plant, operated by U. S. Rubber.
Visco Products Co. Sugar Land, Texas	petroleum fractions	oil treating chemicals	Dr. W. H. Kirkpatrick Ch. Chem.	Products used for demulsification of crude, and for desalting.
Warren Petroleum Corp. Monument, N. Mex.	natural gas	sulfur		Plant owned by Allied Chemical & Dye Corp., operated by Warren.
Wilshire Oil Co. Norwalk, Calif.	refinery gases	sulfur		$148,000 DPA certificate, 3/-4/53. No further information available.
Wyandotte Chemicals Corp. Wyandotte, Mich.	crude petroleum and petroleum fractions	ethylene glycol, propylene glycol, diethylene glycol, ethylene dichloride, propylene chloride, chlorinated solvents, alkyl aryl sulfonate, synthetic detergents, sodium carboxymethylcellulose.	Frank B. Wolcott	
Wynn Oil Co. Azusa, Calif.	petroleum fractions	lube oil additives	Al Foss, Prod. Mgr.	

Petrochemical Plants in Canada

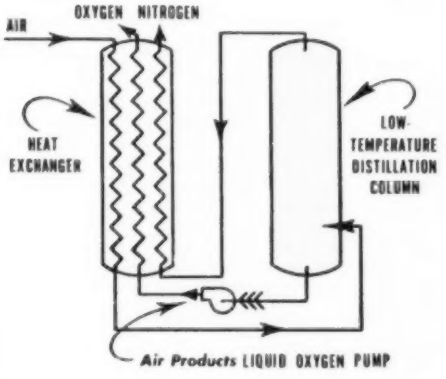
COMPANY AND PLANT LOCATION	HYDROCARBON RAW MATERIALS	PETROCHEMICAL PRODUCTS	PLANT MANAGER OR SUPERINTENDENT	REMARKS
B.A.-Shawinigan Ltd. Montreal, Quebec	cumene	phenol, acetone, acetophenone, mesityl oxide, alpha methyl styrene	R. E. Irwin Pl. Mgr.	New plant, in operation Mar. '53. Company is jointly owned by British American Oil Co. and Shawinigan Chemicals Ltd.
British American Oil Co. Montreal, Quebec	refinery gases	cumene		
Cabot Carbon Co. of Canada, Ltd. Sarnia, Ontario	petroleum fractions	oil furnace blacks	W. F. Hendricks	Plant under construction, scheduled for completion in May '53.
Canadian Chemical Co. Ltd. Edmonton, Alberta	refinery gases, LPG	formaldehyde, acetaldehyde, propionaldehyde, acrolein, propylene oxide, methanol, acetone, acetic acid, N-propanol, propylene glycol, dipropylene glycol, and mixtures of heavier aldehydes, oxides, alcohols, and ketones; pentaerrythitol.	V. T. Anwyll	Plant under construction, scheduled for completion summer '53. Affiliate of Celanese Corp. of America.
Canadian Industries Ltd. Edmonton, Alberta	natural gas	polyethylene		Plant scheduled for completion Oct. '53.
Canadian Industries Ltd. Maitland, Ontario	cyclohexane	hexamethylene diamine and adipic acid	A. T. Fell Works Mgr.	Scheduled for completion by end of '53.
Consolidated Mining & Smelting Co. of Canada Ltd. Calgary, Alberta	natural gas	ammonia, ammonium nitrate	R. S. Woodford Gen. Supt.	
Dominion Tar & Chemical Co. Ltd. Montreal, Quebec	ethane, ethylene	ethylene oxide, ethylene glycol, diethylene glycol, ethylene dichloride, dichloroethyl ether	J. C. Langford	Scheduled for completion May '53.
Dow Chemical Co. of Canada Sarnia, Ontario	refinery gases	ethylene, ethylene oxide, ethylene glycol, styrene, carbon tetrachloride, and other organic chemicals	J. M. Hacking	New ethylene unit in operation Feb. '53.
Gulf Oil Corp. Pincher Creek, Alberta	natural gas	sulfur		Project in abeyance, pending governmental approval of plan providing for outlet of Pincher Creek gas.
Lubrizol of Canada Ltd. Niagara Falls, Ontario	petroleum fractions	lube oil additives		Under construction, completion scheduled for end of '53.
Polymer Corp. Ltd. Sarnia, Ontario	refinery gases	ethylene, butadiene, styrene, synthetic rubbers, other petrochemicals	L. D. Dougan	
Royalite Oil Co. Ltd. Turner Valley Calgary, Alberta	natural gas	sulfur	E. F. T. Stevens	New plant, in operation July '52.
Shell Oil Co. of Canada, Ltd. Montreal, Quebec	refinery gases, propylene	isopropyl alcohol, acetone	G. S. Williamson Supt.	New plant, in operation Mar. '53.
Shell Oil Co. of Canada, Ltd. Jumping Pond, Alberta	natural gas	sulfur		
Vosco Industrial Chemical Products Ltd. Montreal, Quebec	dodecylbenzene and lauryl alcohol	detergents	O. V. Vrany	New plant, in operation early this year.

Giant Oxygen Distillation Column

...part of an *Air Products* Generator for
SPENCER CHEMICAL'S new ammonia plant



Capacity per day
180 TONS OF OXYGEN
350 TONS OF NITROGEN



SIMPLIFIED DIAGRAM of the *Air Products* Generator for Spencer, which will separate oxygen and nitrogen from liquid air. *Air Products* columns of this type also used for low-temperature scrubbing of synthesis gas, hydrocarbon separation, etc.

ON ITS WAY to Spencer Chemical Co.'s new ammonia plant in Vicksburg, Miss. Spencer awarded *Air Products* the contract to design and manufacture a complete Oxygen-Nitrogen Generator.

When in operation, this generator will produce 180 tons of oxygen and approximately 350 tons of high-purity nitrogen per day. Spencer will use the oxygen to produce hydrogen (H), then combine this with the nitrogen (N) to produce ammonia (NH_3).

What are your requirements?

Air Products offers low temperature apparatus custom-made for all gas separation processes, plus a standard line of Oxygen-Nitrogen Generators. Write us your requirements.

Serving the* STEEL, CHEMICAL, PETROLEUM *and* ELECTRONICS *Industries

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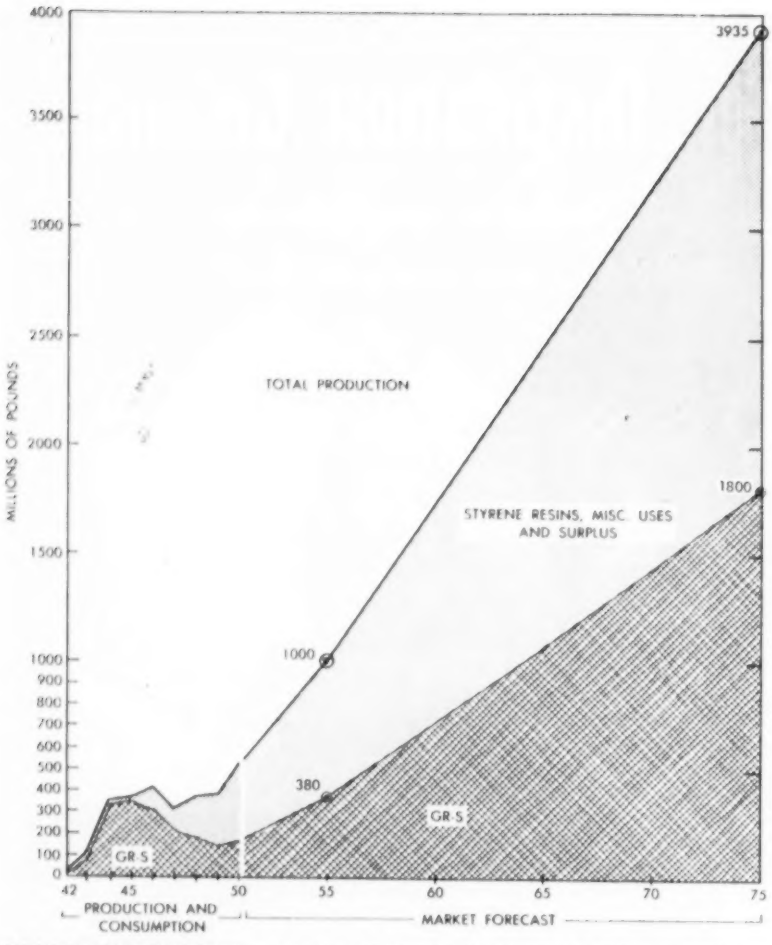
(To obtain more data on advertised products see page 768)



TRENDS IN STYRENE as seen by the President's Materials Policy Commission

STYRENE—

Another promising petrochemical

By ***PETER W. SHERWOOD***
Chemical Engineer
New York, N. Y.

IT IS difficult to realize today that there was no commercial styrene production of consequence prior to 1942. Under the tremendous impetus of the wartime synthetic rubber program, styrene production grew almost overnight into a giant industry. Today this chemical process consumes nearly 45% of the nation's benzene supply.

Four companies are engaged in the production of this important monomer: Dow Chemical Co. (with plants at Midland, Mich., Torrance, Cal., and Velasco, Tex.), Carbide and Carbon Chemicals Co. (Institute, W. Va.) Koppers Co., Inc. (Kobuta, Pa. and an ethyl benzene plant at Port Arthur, Texas), and Monsanto Chemical Co. (Texas City).

A fifth firm, Foster-Grant Co., has announced its plans to build a styrene plant at Baton Rouge, La. Certificates of necessity have been awarded for a number of other proposed installations, the status of which is not known.

The tremendous expansion of the styrene industry since its birth in 1942 is shown in the chart above. It will be noted that almost the entire wartime production went into synthetic rubber. With the slackening of this program, the styrene monomer market softened for a brief interval only to take a sudden upsurge when polystyrene plastics began to take a hold. During the last few years, a number of other uses have acquired significance, among them, the production of styrenated alkyd resins, styrene-butadiene "Latex" type paints, and styrene-phenol resins.

A bright future for styrene growth is forecast. The President's Materials Policy Commission foresees an almost eight-fold increase (see chart above) during the twenty-five year period beginning in 1950:

Market Forecast for Styrene (millions of lbs.)

	1950	1955	1975
For Styrene resins, etc.	355	620	2,135
For GR-S rubber	175	380	1,800
Total	530	1,000	3,935

Petrochemical processes have had an important part in the production of monomeric styrene from the very first. With the exception of relatively small quantities derived from ethanol, the entire amount of ethylene required for styrene production (0.33 lbs./lb. styrene) is derived from natural gas or petroleum sources.

Benzene, the other principal raw material, is originally an off-spring of the coal tar industries. Today, about 30% of the American benzene supply is produced from petroleum stocks in the course of hydroforming operations. In 1952, this source was responsible for the production of 105,000,000 gallons of benzene.

Two manufacturing processes, fundamentally different, are employed for the commercial synthesis of styrene. Volume-wise by far the most important is the direct method, developed in this country by Dow Chemical Co., and later improved by teamwork among a number of chemical and engineering firms. The basic steps involved are shown in Equation (1). Benzene is ethylated to ethylbenzene; and this in turn is dehydrogenated to styrene:

$$C_6H_6 + C_2H_4 \longrightarrow C_6H_5\text{-}C_2H_5$$

$$\xrightarrow{(-H_2)} C_6H_5\text{-}C_2H_3$$

A totally different route is today employed by Carbide and Carbon Chemicals Co. As in the Dow process, the first step is the production of ethyl benzene. From here the method diverges by the use of a somewhat more involved series of reactions, as shown in Equation (2). The ethyl benzene is oxidized to acetophenone, $C_6H_5 \cdot COCH_3$ (methyl phenyl ketone); this in turn is hydrogenated to methyl phenyl carbinol, $C_6H_5 \cdot CHOHCH_3$; and the carbinol is dehydrated to the styrene.

$$C_6H_6 + C_2H_4 \longrightarrow C_6H_5\text{-}C_2H_5$$

$$\xrightarrow{(O)} C_6H_5\text{-}COCH_3$$

$$\xrightarrow{(H)} C_6H_5\text{-}CHOHCH_3$$

$$\xrightarrow{(-H_2O)} C_6H_5\text{-}C_2H_3$$

Simultaneously, some ethyl benzene oxidizes to a negligible amount of the carbinol, in turn dehydrated to styrene:

$$C_6H_5\text{-}C_2H_5 \xrightarrow{(O)} C_6H_5\text{-}CHOHCH_3 \xrightarrow{(-H_2O)} C_6H_5\text{-}C_2H_3 \quad (2)$$

An important early attraction of the Carbide process was the elimination of the very difficult styrene distillation step which almost threatened to defeat the Dow process during its early stages of development.

The two processes are today quite competitive. It should be noted that the economics of the Carbide process are influenced significantly by the sale of acetophenone which is formed as intermediate.

Production of ethyl benzene is the first step in the production of styrene, regardless of the route employed. Indeed on a volume basis, ethylation has become the most important single reaction of benzene.

The reaction is most commonly carried out in the liquid phase in the presence of aluminum chloride. An alternate approach involves high-pressure alkylation over silica-alumina or phosphoric-acid-based catalysts. The latter method avoids corrosive potential and the cost of aluminum chloride replacement. Its disadvantages include, however, not only the inherently high cost of high-pressure operation but also the unsuitability of the vapor phase process for equilibration; i.e. the conversion of polyethyl benzene to ethyl benzene which will be discussed below.

The ethylation of benzene is an equilibrium reaction. The formation of ethyl benzene is favored by the use of low temperatures. Over the entire range of operating conditions employed for the production of ethyl benzene in commercial practice, very high equilibrium constants are observed and almost complete conversion to the alkylate is assured. Thus, the equilibrium constant at 77°C. is as high as 1.91×10^{10} while its value is still 1.66×10^{3} at 327°C.

The alkylation reaction is somewhat complicated by the simultaneous formation of polyalkylated products. In aluminum chloride-catalyzed alkylation, it has been repeatedly reported that ethyl benzene is more rapidly alkylated than benzene itself. Evidence, due to Francis and Reid[1] seems to contradict such a contention, however.

In all likelihood, the apparently more favorable reaction rates observed with alkylated products must be explained by the higher solubility of catalysts in the more complex system. Under suitable reaction conditions, the alkylation of benzene or its lower alkylated derivatives, appears to take place almost instantaneously.

This leads to the natural conclusion that the formation of polyethyl benzene can be kept at a minimum by providing a high ratio of benzene to ethylene (and to monoalkyl benzene), and by providing sufficient contact time to permit establishment of thermodynamic equilibrium in accordance with the relatively slow dealkylation reaction:

$$C_6H_6 + C_6H_5(C_2H_5)_2 \rightleftarrows 2C_6H_5\text{-}C_2H_5 \quad (3)$$

The reaction is carried out commercially in the presence of aluminum chloride catalyst, even where the main alkylation stage is of the vapor-phase type. In such instances, a separate equilibration reactor must be provided. In liquid-phase alkylation plants, the lower polyethyl benzenes are separated from the product and are recycled to the main reactor proper. Since the equilibration reaction is considerably slower than nuclear alkylation, the greater part of the reaction space is used for the conversion of polyalkyls.

Not all the heavy products of benzene alkylation are suitable for recycle, and an intermediate fraction must be selected. Hexaethyl benzene is quite inert to dealkylation treatment.

In addition, a number of secondary reaction products are formed, among them 1,1-diphenyl ethane and 9,10-dimethyl dihydroanthracene. The fraction boiling above 250°C. must therefore be either disposed of as fuel or waste, or it must be subjected to a separate high-temperature dealkylation treatment (in the presence of aluminum chloride-hydrocarbon complex) for the (low-yield) recovery of ethyl benzene and polyalkylate benzenes which are suitable for recycle operations.

Ethylation in the liquid phase as a process was developed in the United States by Dow Chemical Co., Monsanto Chemical Co., and Carbide and Carbon Chemicals Co., working independently at first. Quite similar processes were arrived at by the various investigators, except that Carbide's alkylation calls for the preferred use of slightly elevated pressures.

A somewhat similar (atmospheric-pressure) version, differing in engineering aspects, but providing very similar performance, has been used at the German plants at Schkopau and Huels (formerly part of I. G. Farbenindustrie).

The reaction is carried out in continuous flow. The liquid medium is the mixture of benzene and its various alkylation products through which the catalytic aluminum chloride-hydrocarbon complex is dispersed. In order to operate at highest catalyst efficiency, the presence of a small amount of hydrogen chloride is required. This promoter may be added either as such or in the form of ethyl chloride.

The presence of moisture in the system must be avoided, not only because of its corrosive effect in the presence of aluminum chloride, but also because it will promote a sludge-forming tendency and raise the rate of catalyst consumption. This consideration dictates the careful exclusion of water which must be practiced during the addition of aluminum chloride to the system. Commercial grade aluminum chloride, containing a maximum of 0.05% iron is generally acceptable. Higher concentration of iron chloride in the catalyst salt is considered objectionable because of the deleterious effect on alkylation yield.

"Styrene grade" benzene, with a minimum freezing point of 4.85°C., is suitable for the process. The complete absence of moisture is required and is ensured by azeotropic distillation of the benzene feed (usually jointly with recycle benzene).

The purity of ethylene is not too critical, as long as acetylene, higher olefins, and sulfur compounds are substantially absent. To achieve maximum throughput per unit converter space, ethylene concentration above 94% is desirable, but lower concentrations can be used successfully.

It has been pointed out above that equilibrium considerations necessitate the use of a high benzene/ethylene feed ratio. Since most of the polyalkylated material is recycled to the converter, the ratio is set by the total number of benzene and ethylene groups introduced into the system. The optimum operating ratio of ethyl groups to benzene rings has been found to be in the range 0.55-0.65. This is the ratio selected for commercial operation.

A typical reactor feed is thus made up of 1000 weight parts benzene, 250 parts polyethyl benzene, and 160 parts ethylene.

The converter is a vertical cylindrical tower usually of acid-brick construction, although German practice has leaned toward the use of glass-lining. The liquid height in the unit is maintained at 30-35 ft. All of the reactants are introduced to the bottom of the reactor, while aluminum chloride is fed through the top via a feed pipe which dips below the liquid level.

The system is operated slightly above atmospheric pressure* and at temperatures between 90-100°C. A considerable portion of the exothermic heat of reaction can thus be re-

* Carbide and Carbon Chemicals Co. is reported to operate at elevated pressures.

moved by refluxing benzene by means of overhead heat exchangers.

The reaction product is withdrawn at the top of the reactor. Suspended catalyst complex is carried along with this stream and is separated from it in a settling box. Most of the catalyst so separated is returned to the converter. A small bleed stream is withdrawn from the system and may be discarded or forwarded to the high-temperature dealkylation stage operated for the partial recovery of useful product from the heaviest alkylate fractions.

Aluminum chloride withdrawn in this manner must be supplied by fresh make-up. Under good operating conditions and with specification feeds, catalyst consumption is approximately 3 lbs. per 100 lbs. ethyl benzene produced.

Ethylene conversion is virtually complete; the off-gases, which are substantially free of ethylene, are washed with recycle polyalkyl benzene for the purpose of recovering vaporized and entrained benzene and ethyl benzene. Finally, residual hydrogen chloride is removed by water scrubbing, which may be preceded by a caustic wash.

The main product stream contains approximately 40% benzene, and an equal amount of ethyl benzene. The remainder is principally composed of polyalkyl benzenes.

Before this hydrocarbon mixture is subjected to fractionation, it must be carefully freed of contained acid by caustic washing. Suitably lined, stirred kettles are used in this operation in continuous flow.

Mitchell[2] has described an alternate neutralizing method which is employed at Dow's Midland plant. In this instance, an oversized centrifugal pump serves to mix the aqueous and organic phases intimately. Thorough separation of the two layers is required, regardless of the method selected.

Overall benzene efficiency of liquid-phase alkylation is in the range of 94-96% of theory. Ethyl benzene yield, based on ethylene is in the same range and has, indeed, been reported as high as 96-97%.

Vapor-phase ethylation, the alternate commercial process for the synthesis of ethyl benzene, involves vapor-phase alkylation at high pressures. The principal catalysts useful for this operation are typified by the system alumina-silica and by phosphoric acid (or a phosphate) on suitable carriers.

Of importance is a process developed by Universal Oil Products Co. which ethylates benzene in the presence of phosphoric acid on kieselguhr. The method is analogous to the more wide-spread vapor-phase propylation of benzene which was until recently of outstanding significance in the production of cumene for aviation gasoline blends. The process is now experiencing a resurgence due to the sudden need for large-scale production of cumene to serve as intermediate in a novel synthesis of phenol.

It has been pointed out above that the vapor-phase process for the production of ethyl benzene is not suitable for the dealkylation of polyalkyls. It is therefore necessary to obtain maximum ethylene efficiency and to keep the formation of polyalkyl benzene at a minimum.

This is of special importance where there is no auxiliary unit to achieve the equilibration reaction in the liquid phase. In any case, such auxiliary units are costly to operate and are relatively small, and load on them must be kept at a minimum by efficient operation of the primary vapor-phase reactors.

The ratio of benzene to ethylene fed to the reactors is the most important single variable determining the course of the reaction. According to Ipatieff, a benzene-ethylene ratio of 3:1 will result in an alkylate containing only 87 wt-% monoethyl benzene. By boosting the molar ratio of reactants to 5.0, the ethyl benzene content of the alkylate is raised to 93%. The need to operate at high benzene ratios imposes a severe burden on the benzene topping system which follows the reaction stage, and this constitutes a major drawback of the vapor-phase methods.

Another disadvantage is the need for high-pressure operation with resultant high steel requirements and compression charges for ethylene. Operation at 325°C., a liquid hourly space velocity of 2.0, and a pressure of 600 psi gave a per-pass conversion of only 80% of the ethylene fed to the system. This could be boosted to 95% by raising the operating pressure to 900 psig, while keeping all other variables unchanged.

High-pressure operation will also permit a boost in throughput per unit reactor volume at any given temperature. The actual operating temperature selected for the process is a compromise between the desire to obtain high unit capacity and the tendency of the catalyst to deteriorate more rapidly at higher temperatures. Dehydration and fouling by carbon deposition are the two principal factors which tend to reduce catalyst life. The tendency of the catalyst to lose its water at even relatively mild reaction conditions can be overcome by the injection of small amounts of water with the benzene feed or by the introduction of a limited amount of ethyl alcohol.

Multi-stage operation may be carried out on vapor-phase alkylation with beneficial effect on the overall yield. In this version of the process, only a portion of the total ethylene is fed to the primary reactor, the remainder being added to the benzene-alkylate mixture on its way to succeeding stages. Such a system will maintain a high benzene:ethylene ratio at any point in the reactors, while keeping the overall feed ratio low.

This approach is made possible by the sluggishness of the dealkylation reaction which prevents establishment of true equilibrium with polyalkyl benzenes in the course of passage through the reactor. Thus, Mattox[3] obtained for a benzene:ethylene ratio of 6.0, an alkylate containing 96 wt-% monoethyl benzene by reacting in four stages. At otherwise the same conditions, the alkylate obtained in single-stage processing contained only 85% of the desired product.

Purification of ethyl benzene: Regardless of the alkylation process selected, it is necessary to recover ethyl benzene in a state of high purity before it may be converted to styrene. Most harmful is the presence of diethyl benzene in the feed to the styrene plant. This will eventually lead to the formation of highly reactive divinyl benzene, an objectionable impurity in most polymerization processes, and a troublemaker in the styrene stills.

Fractionation of the product from aluminum chloride-catalyzed alkylation calls for the use of three separate still systems: Benzene topping, ethyl benzene recovery, and polyethyl benzene (recycle) purification. The latter stage may be eliminated in vapor-phase alkylation plants.

The distillation system to be described applies specifically to a plant employing liquid-phase alkylation (in which the crude product contains less benzene and more polyethyl benzene than is the case in vapor-phase alkylation). However, the system employed for distilling the product from high-pressure reactors is similar and no need is felt to go into details of required modifications.

The separation of benzene from ethyl benzene is straightforward, operating above all to remove benzene quite completely from the bottoms. A small amount of ethyl benzene in the overhead is less critical since this material will eventually be returned to the reactors and is therefore not lost from production.

The column is operated at substantially atmospheric pressure. Benzene columns vary in height from 20 to 50 actual plates, depending on the reflux ratio selected. In one instance, known to this writer, the separation is carried out satisfactorily in a 45-plate column operated with a reflux ratio of 1.0.

The overhead joins the make-up benzene and is subjected to an azeo-

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tropic drying treatment on its way to the alkylator. The bottoms from the primary benzene still are a complex mixture of alkylated benzenes. In the case of liquid-phase alkylation, which is here under consideration, this stream will contain some 65% ethyl benzene.

Recovery of this hydrocarbon is effected in the ethyl benzene column where the purified product is taken overhead. Again, operation is at slightly above atmospheric pressure. Typical column size calls for 57-58 plates at an operating reflux ratio of 3:1.

The bottoms from the ethyl benzene still are taken to the polyalkyl benzene column for the separation of recycle stock from the heaviest components. The operation is carried out at 25-50 mm. Hg. abs. While the first two columns are generally of the bubble-cap tray type, the polyalkyl benzene still—which does not require very sharp separation—may be carried out in packed towers. The overhead is returned to the primary alkylators where it serves as equilibration stock to boost overall yield in accordance with the precepts outlined above.

The bottoms leaving the polyalkyl benzene still are joined by spent aluminum chloride-hydrocarbon complex and the mixture is treated in high-temperature dealkylation at 200°C. for the partial recovery of benzene and lower alkylates. This operation tends to bring about rapid fouling of the heat transfer walls and recourse must be had to mechanical means (such as rotating scraper blades) to maintain the metal sides of the unit unobstructed.

Dehydrogenation of ethyl benzene, the next step in the direct process for producing styrene, will be discussed in the next article on this petrochemical, scheduled for publication next month.

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(3) Mattox, W. J., *Trans. A.I.Ch.E.*, Vol. 41, p. 470 (1945).

Do You Know These Words?

Introduced last month, this new regular department brings you not only new arrivals in your petrochemical vocabulary but also some which may already be familiar in textbooks. Many are chemicals produced previously in volume from non-petroleum sources and now produced from petroleum because, for example: 1) a new process permits a lower price, 2) demand exceeds supply available from non-petroleum sources, 3) a petroleum company has a raw material which it can upgrade to meet competition at an established price.

By B. H. WEIL
Head, Information Division
Ethyl Corp. Res. and Engrg. Div.
Detroit, Mich.

Acrylonitrile

ACRYLONITRILE, pronounced "ah-**krill**-oh-nigh-**trial**," has the formula $CH_2=CHCN$. It is a toxic, colorless liquid of mild odor, is soluble in most organic solvents, weighs 6.7 lbs. per gal., freezes at —82° C., and boils at 78° C.

Acrylonitrile is produced commercially either: (1) by the reaction of ethylene oxide (C_2H_4O) with hydrogen cyanide (HCN) to yield ethylene cyanohydrin ($CH_2(OH)CH_2CN$), followed by catalytic dehydration; or (2) by reaction of acetylene (C_2H_2) with ammonia (NH_3).

An industrial chemical for only the past 15 years, its use until recently was confined almost entirely to the manufacture of the Buna-N type of oil-resistant synthetic rubbers. Other uses included plastics, organic synthesis, grain fumigants. Now, however, acrylonitrile is finding rapidly growing use in the manufacture of popular synthetic fibers, a field which will require quantities into the hundred millions of pounds annually.

All the raw materials for the manufacture of acrylonitrile are being produced from petroleum or natural gas, although not all acrylonitrile manufacturers use these sources exclusively. Ethylene oxide, the chief raw material, is normally produced from petroleum ethylene. Hydrogen cyanide can be made from methane (from natural gas) and ammonia. Acetylene is being produced by pyrolysis of petroleum or natural gas by at least some acrylonitrile producers. Ammonia is also produced in large quantities from natural gas.

Acrylonitrile is an important petrochemical, one which will continue to be produced in rapidly growing quantities from petroleum and natural gas by present commercial methods or by several other known procedures.

Pentaerythritol

PENTAERYTHRITOL, pronounced "**pen**-ta-ee-rith-ri-tall;" formula, $C(CH_2OH)_4$. It is a white, crystalline powder, soluble in water, sweet-tasting, and little more than half as heavy (per unit volume) as table salt. Its melting point is well above the boiling point of water.

Pentaerythritol is customarily produced by the reaction of acetaldehyde (CH_3CHO) with formaldehyde (HCHO) in an alkaline solution; sodium or calcium formate is produced as a co-product.

An industrial chemical only during the past 14 years, its use during World War II was divided almost equally (under allocation control) between plastics and explosives. For the later application, it was nitrated to yield the high-power explosive NETN (Penta-Erythritol-Tetra-Nitrate). Current production (around 60,000,00 lb. annually) is more than four times greater than the wartime level, because of demands from the plastics industry, where it is replacing glycerine in the production of alkyd resins (used in paints, varnishes, and lacquers), often yielding better resins at lower costs.

Pentaerythritol is also finding increasing use in the production of other resins and synthetic drying oils (also used in paints) and in the synthesis of wetting agents (cousins of detergents), used in the manufacture of wax compositions, synthetic rubbers, dust-resistant lubricants, and so on.

Both of the raw materials for pentaerythritol are produced in large quantities from natural or refinery gases. Acetaldehyde is normally produced from ethyl alcohol or acetylene (themselves important petrochemicals), while formaldehyde is produced from methanol (a petrochemical) or by oxidation of LPG or LRG (which also yields some acetaldehyde). Because of its present and potential uses, pentaerythritol will probably be in increasing demand; at least two new producers are expected to join the three at present in this field.

What words puzzle you *in your reading of petrochemical literature? Tell us about them and we'll try to include definitions in this, your new words department. Write either the author, or the editor:*

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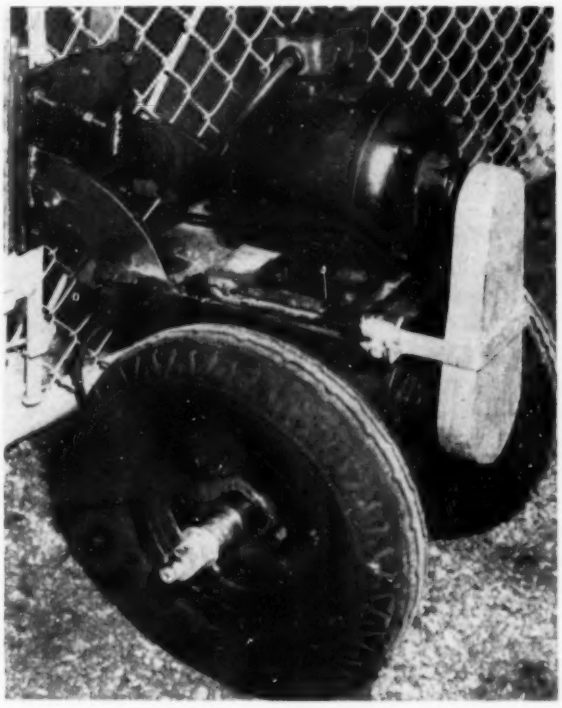

Auto-Gateman Keeps Guards Dry

TO keep guards from personally opening and closing plant gates during inclement weather, an electric gate opener has been devised by Carl Elliott, machine shop foreman at Socony-Vacuum Oil Co.'s East Chicago, Ind. refinery.

Mr. Elliott did the job with salvage items usually found in any refinery. Vital part of the device, which is essentially a pneumatic-tired "electric mule", is an old speed reducer, turned upside down with its base bolted to a plate on which a fractional horsepower motor is mounted. Wheelbarrow tires and wheels are located on the low-speed shaft.

As the photographs show, the unit is attached to the gate, pushing it closed or pulling it open on a button signal from the guard house. A cover made from a sawed five gallon can serves as a protective housing for the motor on rainy or snowy days.

What's Your Problem?

There's a chap in a petrochemical plant down on the Gulf Coast who'd like to know how others dispose of used filter-aid discharged from rotary vacuum filters. Got an answer for him?

One plant we know used to burn the darn stuff, although they did find it had some detergent qualities.

We'll be glad to publish acceptable and practical answers.

Plant Practices Editor
PETROLEUM PROCESSING
1213 West Third St.
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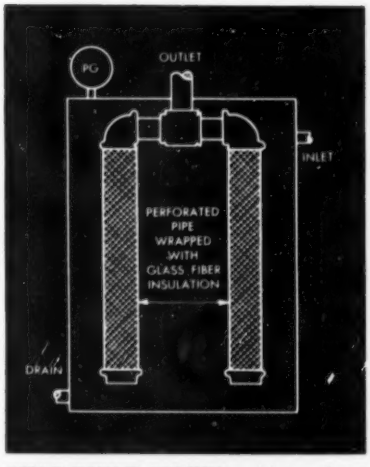
Simple Unit Solves Filter Problem

*By T. C. LEATHERWOOD**

CONTAMINATION from an undetermined source was giving considerable trouble in the circulation of di-ethylene glycol at the Rock Springs, Wyo., gasoline plant of Mountain Fuel Supply Co. It plugged up the pump lubricators, partially plugged heat exchangers and various lines where the velocity was low.

A simple, shop-built pressure filter, made of a discarded steel cylinder and using glass fiber aircraft type insulation, $\frac{1}{2}$ in. thick, as a filtering medium, turned the trick. It is shown in the accompanying sketch. Very little pressure was required to force the glycol through. A pressure gage installed on the upstream side of the filter provided the indication



SHOP-BUILT FILTER which solved a problem with dirty di-ethylene glycol

*Mr. Leatherwood is assistant plant superintendent at the Rock Springs, Wyo., gasoline plant of Mountain States Fuel Supply Co.

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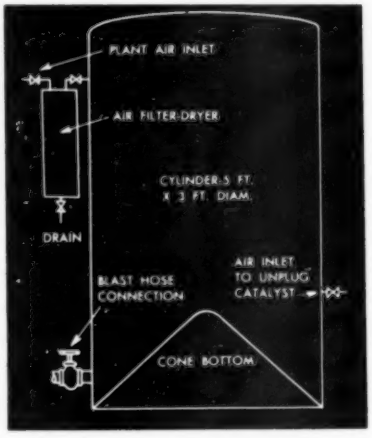
as to when the medium needs changing.

Construction of the filter is a matter of choice and what materials are at hand. At Rock Springs, the filter body was made of a steel cylinder, ¾ in. thick, 28 in. in diameter, and 30 in. high. It was found in the junk yard and its prior use was not known.

Frequency of changing the filter depends upon how dirty the fluid is. About 1600 gals. of very dirty diethylene glycol was filtered at first, and then the filter needed changing. Subsequently, a side stream of 1½ gpm. of the glycol has been passed through the unit at about 10 psi. pressure. The filter has not been changed for about two months and the pressure has not gone up.

Before the present filter was built, a pre-coat type unit was rented and it did an excellent job but was too costly.

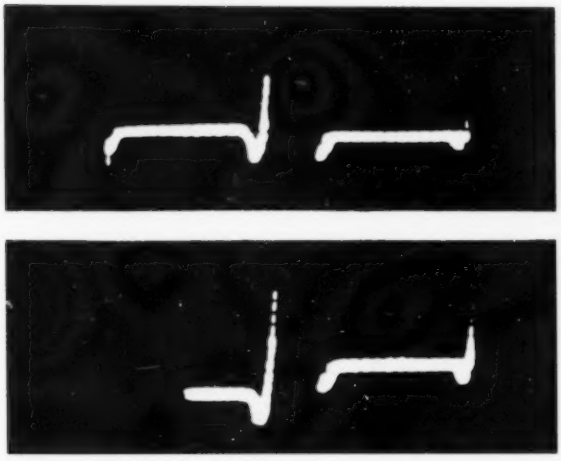


Spent Catalyst Useful In Cleaning Exchangers

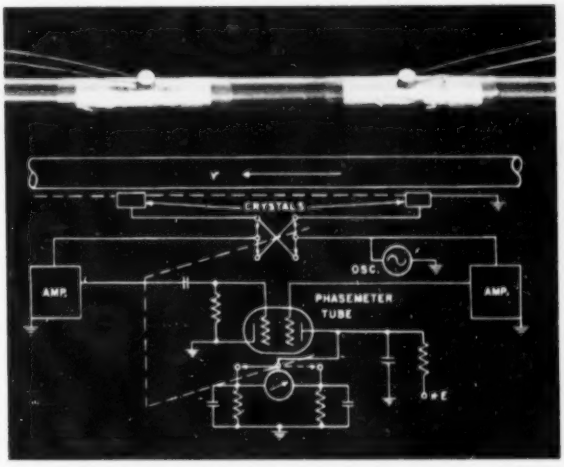
SPENT catalyst can be used to particular advantage in blast-cleaning of heat exchanger bundles, particularly brass or bronze tubes where sand tends to pit the metal surfaces. As practiced by maintenance personnel at Esso Standard Oil Co.'s Baltimore refinery, the catalyst is used with a small, portable pressurizing tank which can be carried about from job to job.

As shown in the sketch, the tank is a 5 ft. high by 3 ft. diameter metal cylinder with an inverted cone bottom. Plant air, at an average pressure of around 60 psi. and occasionally as low as 40 psi., is perfectly satisfactory, it has been found. The unit is connected to a plant air system outlet as shown. In addition, a small air inlet is provided near the bottom to keep catalyst from clogging.

(*To obtain more data on advertised products see page* 768)



SONICS MADE VISIBLE in oscilloscope patterns indicates flow velocity. Difference in height of flat portions of trace is a measure of velocity



ELECTRONICS CONVERT sound waves from two piezoelectric exciters on the pipe to energy measured by a calibrated electronic voltmeter

Sonics + Electronics = Flowmeter

A NEW type of electronic flowmeter, capable of measuring rapid flow of fluid in pipe, has been developed at the National Bureau of Standards. It utilizes the change in velocity of sound waves as a measure of fluid flow.

Advantages cited for the device are that it has a very fast response and does not obstruct the fluid currents in making the measurement. In addition, the signal-to-noise ratio is sufficiently high to permit the measurement of extremely small velocities.

Most present methods for measuring the velocity of flowing liquids depend upon mechanical devices that usually introduce discontinuities in the fluid and have inherent inertia which prevents faithful reproduction of fast changes in velocity. One type of flowmeter utilizes the principle of the homopolar machine: but this cannot be used for gases, and the instrument is at present restricted to the measurement of conductive fluids. Another method makes use of the resistance change in hot wires placed in the path of fluid flow. However, besides presenting an obstruction to the flow, the hot wire is not generally applicable to fluids that would change chemically or physically as a result of the heat from the wires.

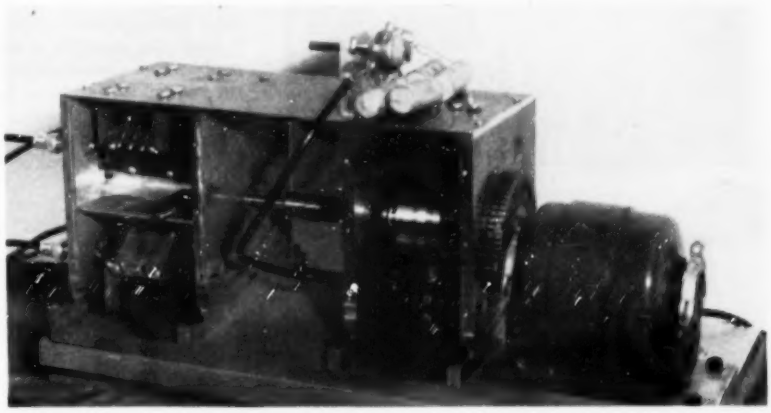
In the new NBS flowmeter, a sound wave is transmitted over a fixed distance through the flowing fluid, and the phase of the received wave is compared with that of the transmitted wave. The sound energy is imparted to and taken from the fluid through the walls of the containing vessel.

No part of the measuring system need come into contact with the medium under study. This makes the unit applicable to detecting flow of chemicals in a closed system, for example, the coolant in a chain reactor. Minor modifications will permit its use on such fluids as gas or oil in a metal pipe.

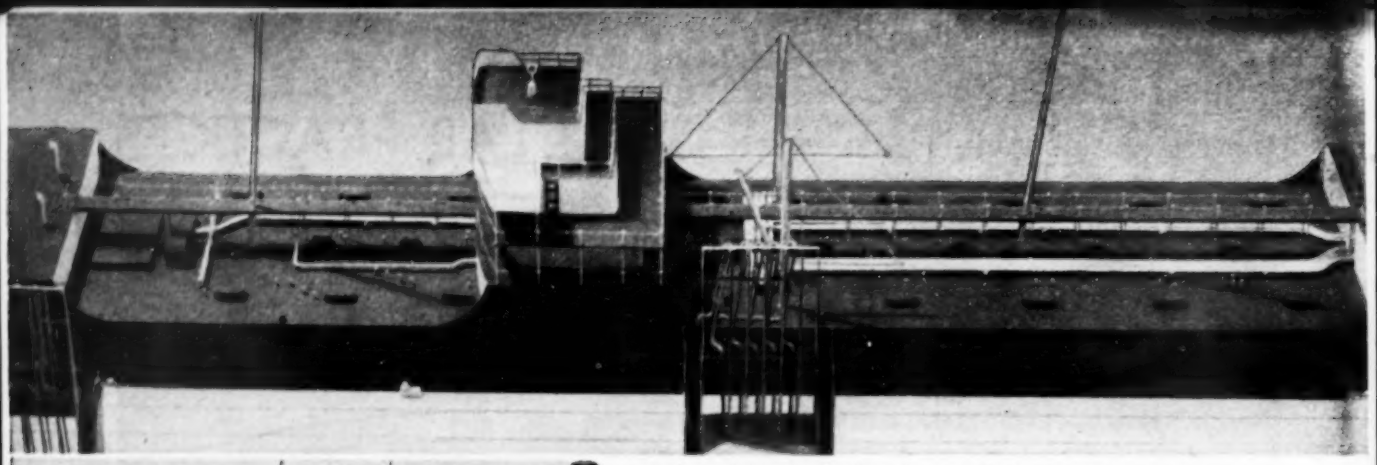
In instances other than those involving extremely high velocities—wind tunnels for example—a simple system utilizing merely a stationary device to transmit energy into the medium and another stationary unit to receive it would be impractical. This is because changes in distance or propagation velocity would produce errors far greater than the variations due to flow.

For this reason, the transmitter and receiver of the NBS flowmeter are exchanged periodically without varying their locations. This is accomplished by using identical magnetostrictive or piezo-electric exciters—such as barium titanate crystals—as transmitter and receiver, and switching their connections alternately to the receiving and transmitting channels.

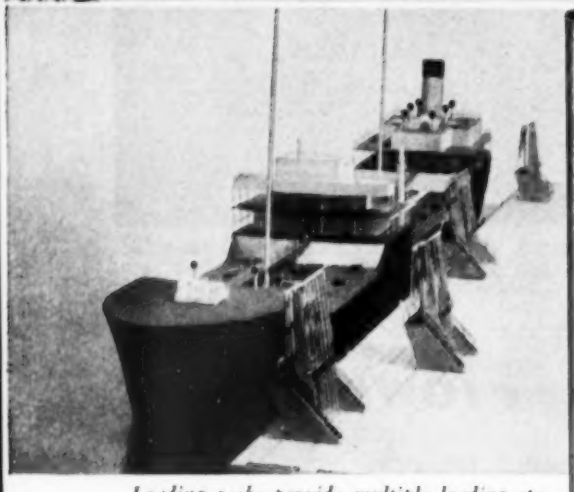
Thus the phasemeter displays two phase shifts alternately: one a function of the sound velocity plus the fluid flow, and the other a function of the sound velocity minus the flow.



MECHANICAL SWITCHING SYSTEM uses commutator (left) and switching unit for the synchronous rectifier (right), driven by an electric motor



Scale model tanker (⅛" to 1') made for demonstration purposes.



Loading racks provide multiple loading stations. Manifold lines under dock are easily connected to loading racks.

Larger model of a loading rack demonstrates flexibility of Chiksan aluminum marine and barge hose. Ship to shore connections can be easily handled by one man in a few minutes.

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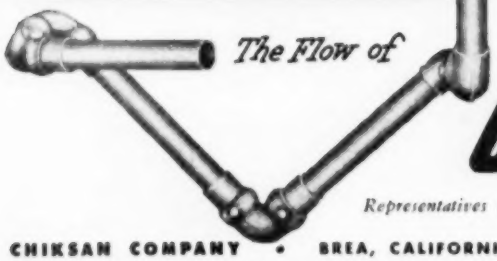

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The difference between the two phase shifts is a measure of the fluid velocity.

The switching can be made to operate faster than the inherent variations occurring in either the transmitter, receiver, or even the medium. Hence, the variations will occur at a minimum of one complete transmitter-receiver switching cycle, and the phase difference will remain unaffected.

In the first experimental model of the NBS flowmeter, a mechanical switching system operating at a 10-cycle-per-second rate is employed. The switching is achieved by a commutator that is inserted between the crystals on one side and a 100-kc oscillator and receiver on the other. The oscillator is connected to an amplifier containing carefully designed limiters that produce a square wave voltage to be injected on one grid of a multigrid phasemeter tube. The receiver amplifier also furnishes a limited signal to the other grid of the phasemeter tube.

The phasemeter tube is by-passed by a capacitor so that fluctuations at the sound wave frequency are removed and the fluctuations at the switching rate may be applied to a synchronized rectifier. The rectifier is actuated in synchronism with the commutator, but its active period is shorter so that the harmful transients occurring during the crystal transition are suppressed.

A simple commutator, merely switching the crystals alternately to receiving and transmitting channels, is unsuitable because of the capacitive cross-coupling between the two channels. In order for the transmitted and received pulses to be absolutely representative of the separation between the crystals and the fluid velocity there must be a minimum of coupling between the two channels. By very careful design of the commutator, the leakage capacitance can be reduced to about 5×10^{-5} $\mu\mu$f., and much of the fringe effects and ground currents are eliminated.

The rotor of the commutator is made in the form of a sandwich, consisting of two pieces of insulating material fastened to a grounded conductive shield. Two conductive segments or sectors are mounted to the insulating material but with no connection to the shield. The shield is brought out to the maximum diameter of the rotor, thereby reducing the fringe effects between the sectors.

Four rows of carbon brushes are arranged so that the crystals are connected to either the receiver or oscillator for all positions of the rotor. Capacitive coupling between the sectors is reduced by maintaining a clearance of less than 0.015 in. between the sector shield and the rotor.

The output of the phasemeter is applied to an electronic, high-impedance voltmeter (which can be calibrated directly in terms of velocity) through the rectifier-switch geared to the commutator drive.

Fast velocity changes can be observed on the screen of a cathode-ray oscilloscope connected to the plate of the phasemeter tube. Thus, if the plate voltage is made visible, the difference between the voltages developed "upstream" and "downstream" can be used directly to estimate the flow-velocity instantaneously.

A modification to the commutation system is the use of an electronic switch. By using vacuum tubes, the switching frequency can be increased to 1000 cycles, for example, and the time of response can be correspondingly shortened.

Four pentode amplifiers are placed between the crystals on one side and the oscillator and receiver on the other. The screen-grid supply is derived from a square-wave generator with a frequency equal to the switching rate (1000 cps.). When the screen voltage is positive, the pentode acts as a normal amplifier: when the potential becomes negative, the electron stream in the tube is blocked and good shielding is provided. The amplifiers are so arranged that one pair operates at a time during each half of the switching cycle.

Further modifications in the flowmeter are being considered. One in particular is concerned with flow in metal pipes. A pulsed and gated phase comparison system will be used for this purpose to eliminate the effects of the direct transmission of the sound through the wall of the pipe.

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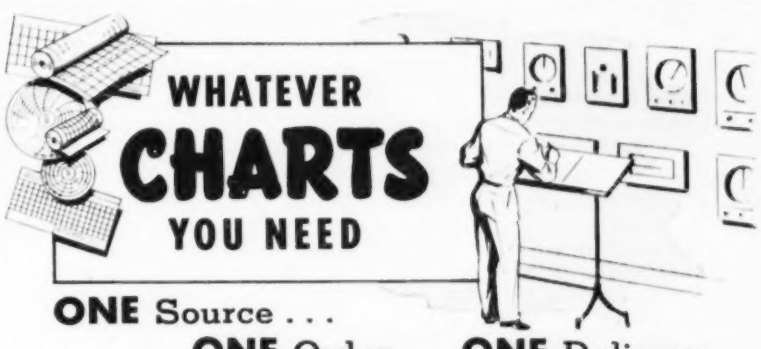

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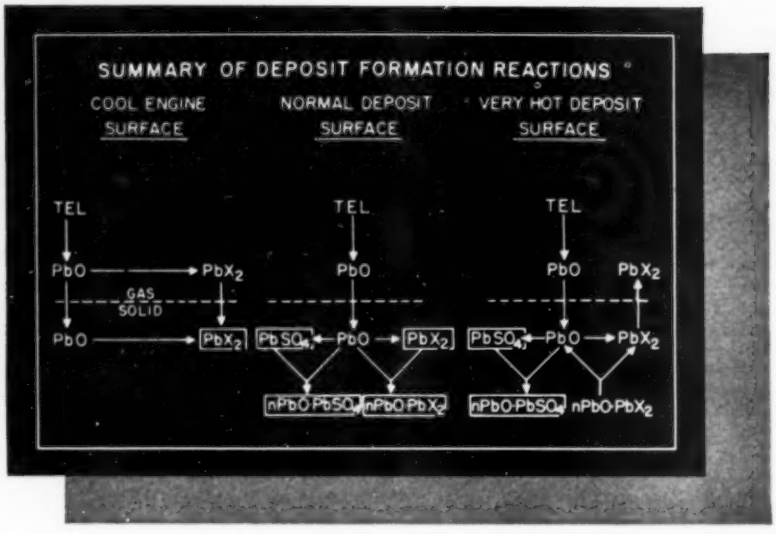

THIS CHART SHOWS the compounds found in the deposit and the reactions by which they are produced under each of the temperature conditions studied.

New studies reveal

The sequence of chemical reactions which occur in engine deposit formation

Combustion chamber deposits, which increase the tendency of fuels to knock, have long presented a problem to petroleum engineers working on the improvement of fuel performance.

Until recently, however, very little was known about the reaction mechanisms which result in the accumulation of these deposits—especially with fuels containing tetraethyl lead. And nearly all modern automotive fuels contain this antiknock compound.

SINCE DU PONT is a large supplier of tetraethyl lead, the Du Pont Petroleum Laboratory recently undertook a study of the sequence of chemical reactions which occur in combustion chamber deposit formation.

Although almost all tetraethyl lead decomposition products are removed from the combustion chamber with the exhaust gases, a small amount remain on the chamber walls in the form of inorganic lead salts.

Engine deposits also contain a certain amount of carbonaceous materials from incomplete combustion, and both metallic and nonmetallic compounds introduced with the air, fuel or oil, and from engine wear. **THESE DU PONT STUDIES**—part of a continuing series of systematic investigations on the mechanisms causing combustion chamber deposits—were limited to the formation of the lead salt portion of the deposits.

The results are summarized in the chart above. For full details on the results and their significance, ask any Du Pont Petroleum Chemicals representative or district office for a copy of "The Mechanism of Combustion Chamber Deposit Formation with Leaded Fuels."

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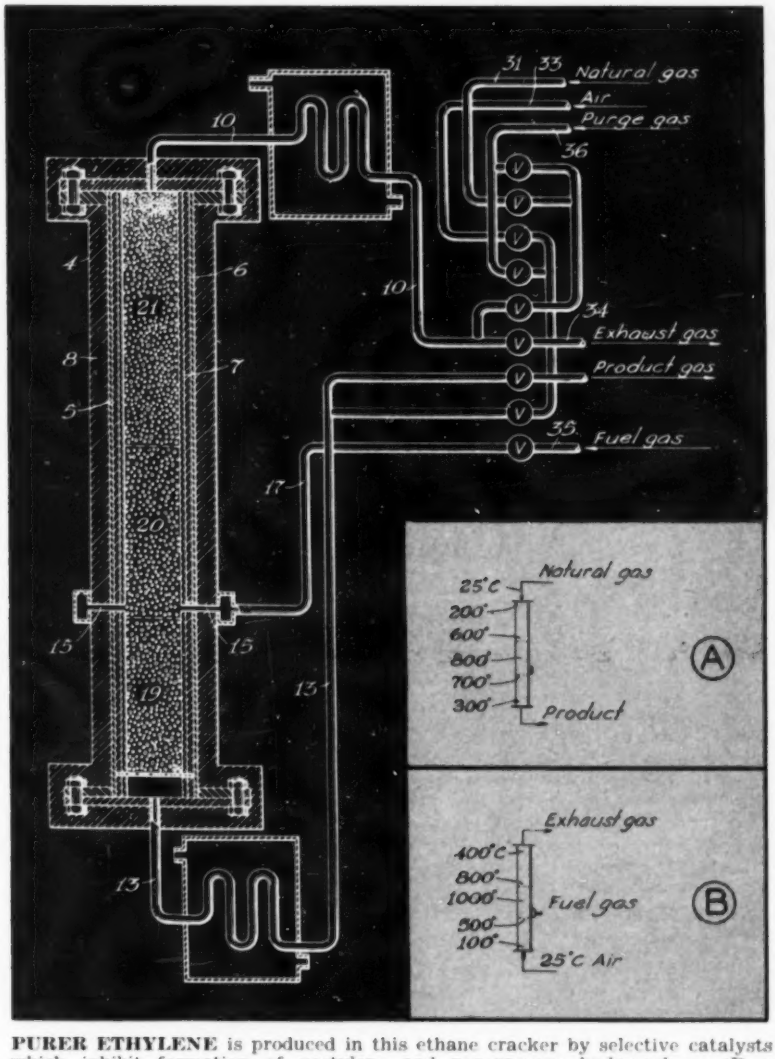
By Peter J. Gaylor, *Patent Attorney, Gaylor, Cifelli & Jurick, Newark, N. J.*



PURER ETHYLENE is produced in this ethane cracker by selective catalysts which inhibit formation of acetylene and non-gaseous hydrocarbons (Dow Chemical Co.—U. S. 2,629,753)

Catalyst Improves Purity of Ethylene Produced by Pyrolysis of Ethane

RECENT petrochemical interest in ethylene has been high-lighted by Gulf Oil Corp.'s placing in operation its Port Arthur plant producing 2½ billion cu. ft. per year of ethylene, with a second plant of the same size under consideration. Therefore, of interest in this connection is Dow Chemical Co.'s patent 2,629,753 for producing ethylene by selective pyrolysis of ethane.

This patent points out that when ethylene is made by straight pyrolysis of ethane and heavier hydrocarbons at above 750° C., there are produced significant amounts of acetylene, gasolines, tars and solid cyclic hydrocarbons formed at the expense of the ethylene yield which create serious operating difficulties in fouling, gas purification, etc.

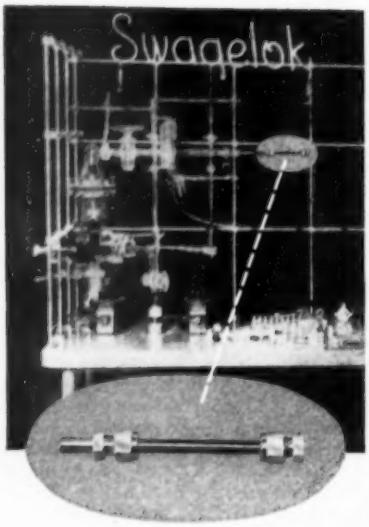
The patent discloses that there is a small group of catalytic materials which at 800°-1000° C. act selectively to accelerate cracking of ethane and higher paraffins to ethylene and still inhibit formation of acetylene and non-gaseous hydrocarbons. Such catalysts are essentially infusible refractories not reducible by hydrocarbons at 1000° C., having a surface area of less than 1 sq. m. per gm. and which have disposed on their surface 0.001-1% by weight of manganese, iron, copper or cobalt. During contact with the catalyst at 800°-1000° C., the hydrocarbon is pyrolyzed largely to ethylene and the latter may be used directly without purification for many chemical syntheses. Carbon produced during the pyrolysis is deposited on the catalyst and is removed during regeneration by burning off. Since the catalysts employed are refractories, they are well adapted for use as heat-storing media, thus permitting the pyrolysis to be carried out by a cyclic regenerative procedure.

Refractories most satisfactory for such use are metal oxides or silicates such as silica, alumina, beryllia, thoria, magnesia, lime, titania, zirconia, chromia and hafnia, alone or in combination with silica. Non-basic refractories are preferred because of their greater resistance to oxides of carbon. The refractory may be in the form of sillimanite or mullite pebbles of 0.2-1-in. diameter, or in the form of Berl saddles (patent 1,796,501).

Of the promoters already specified, iron is active in lower concentrations than the others, although a proportion of at least 0.1% is preferred for each of the metals. Copper tends to exert a fluxing action on some silicates, so a suitable refractory in this case is aluminum silicate, or, better yet, a non-silicate such as alumina. Since the pyrolysis is highly reducing, a salt such as the nitrate or acetate may be used, rather than the metal.

Cracking temperature preferably is 900°-950° C., and residence time not over 2 sec. Under these conditions of pyrolysis, the cracked gas contains too little acetylene to interfere with most of the uses to which the ethylene made is put, but even these traces may be removed by passing the gas at 140°-375° C. over a bed of refractory pieces impregnated with 0.5-2% copper oxide (as disclosed in patent 2,398,301).

The diagram above illustrates schematically the apparatus which may be employed. Insert A shows temperature distribution in the unit during cracking, while Insert B gives distribution during regeneration. It will be observed from the diagram that the ethane-containing natural gas entering in line 31, passes through inlet 10 and into preheat zone 21 filled with ½-in. untreated



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mullite pebbles. Then it enters cracking zone 20 filled with catalyst such as ½-in. mullite pebbles having 0.1% of iron distributed on the surface. Quench zone 19 is filled with ½-in. mullite pebbles, the surface of which has 1% by weight of copper oxide (prepared according to patent 2,398,301). The cracked gases leave through outlet 13.

During the regeneration cycle, air from inlet 33 enters line 13 into reactor 4 and out through lines 10 and 34. At the same time, fuel gas introduced through line 35 enters through line 17 and inlets 15 and merges with the air stream. Between the two cycles, the reactor may be purged with inert gas such as steam or nitrogen entering through line 36.

The cylindrical reactor 4 is formed of a steel shell 5 lined with courses of insulating brick 6 and a refractory brick 7, and lagged with heat insulation 8.

Typical results obtained from a natural gas feed stock are given below:

Component	Natural Gas vol.-%	Cracked Gas
CH_4	73.3	65.6
C_2H_6	13.9	4.8
C_2H_4	0	10.5
C_2H_2	0	0.25
C_3'S	5.9	2.2
C_4'S	1.7	0.5
C_5'S	0.6	0.7
H_2	0	9.6
N_2	4.6	5.2

In this case, the conversion of ethane to ethylene was 51.5%, the chemical efficiency of the conversion was 96.9%, and the cracked gas was clear and colorless with no appreciable quantity of tar or liquid condensate recovered.

Patents Issued in March

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for March 3, 10, 17, 24, 31, 1953, *Vol.* 668, *Nos.* 1-5.

PROCESSES

Catalysts

2,630,616-7 (Phillips Petroleum Co.) Stabilized alumina pebbles.
2,631,123 (Standard Oil Development Co.) Process and apparatus for hydrating cracking catalyst.
2,631,124 (Standard Oil Development Co.) Magnetic decontamination of cracking catalyst.
2,631,134 (E. I. du Pont de Nemours & Co.) Silica sol process.
2,631,136 (Universal Oil Products Co.) Preparation of an alumina-halogen-platinum catalyst.
2,631,927 (Shell Development Co.) Apparatus for removal of carbonaceous deposits from powdered solids (regenerator).
2,631,968 (Shell Development Co.) Separation of powdered inactive catalysts from active catalysts.
2,631,981 (Sinclair Refining Co.) Rejection of inactive material from a fluidized catalyst regenerator.
2,631,983 (Houdry Process Corp.) Preparation of siliceous catalyst beads containing free magnesia.

Conversions

2,630,306 (Socony-Vacuum Oil Co.) Subterranean retorting of shales.
2,630,307 (Carbonic Products, Inc.) Method of recovering oil from oil shale.
2,630,404 (Universal Oil Products Co.) Hydrocarbon conversion process by contacting straight run gasoline with olefinic hydrocarbon in presence of platinum.
2,631,089-90 (Standard Oil Development Co.) Apparatus for conducting conversion operations in fluidized systems.
2,631,928 (Sinclair Refining Co.) Catalytic cracking apparatus.
2,631,967 (Phillips Petroleum Co.) Process and pebble apparatus for converting reactant materials.
Re 23,638 (Sun Oil Co.) Catalytic reaction apparatus.
2,632,527 (Thermix Corp.) Apparatus for separating suspended particles from gases.
2,632,692 (Hydrocarbon Research, Inc.) Multiple bed catalyst apparatus.
2,632,727 (Standard Oil Development Co.) Cracking of hydrocarbon oils with silica gel.
2,632,731 (Technical Assets, Inc.) Process for the production of acetylene from liquid hydrocarbons by electric arcing.
2,632,739 (Standard Oil Development Co.) Molybdate catalyst for producing aromatic hydrocarbons.
2,633,449 (Sinclair Refining Co.) Thermal conversion of heavy hydrocarbons.

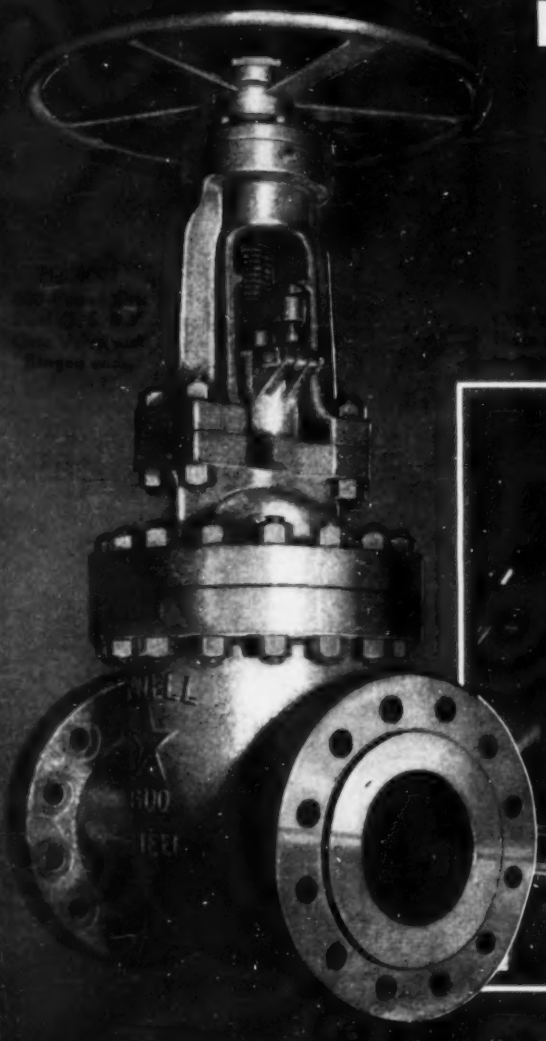
Hydrocarbon Synthesis

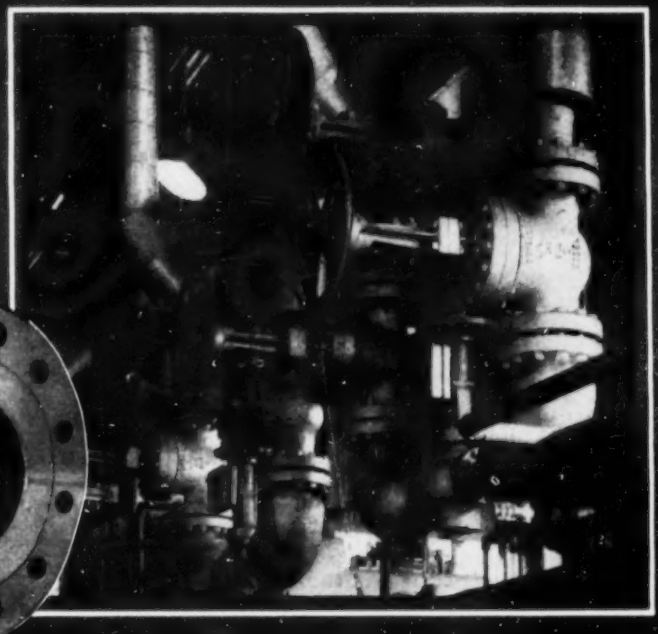
2,630,378 (Texaco Development Corp.) Generation of synthesis gas by oxidation of high boiling hydrocarbons.
2,630,447 (Michael Steinschlaeger) Process for the synthetic manufacture of olefinic hydrocarbon oils from CO and H_2.
2,631,086 (Standard Oil Development Co.) Water gas shift catalyst (Fe-Cr) preparation and water gas shift process.
2,631,094 (Standard Oil Co.-Ind.) Natural gas conversion to hydrogen and carbon monoxide.
2,631,159 (Hydrocarbon Research, Inc.) Hydrocarbon synthesis.
2,631,933 (Standard Oil Development Co.) Process for the manufacture of synthesis gas by oxidation of hydrocarbons.
2,631,934 (Standard Oil Development Co.) Method of manufacturing a gas rich in carbon monoxide from solid carbonaceous material.
2,632,014 (E. I. du Pont de Nemours & Co.) Process for preparing high molecular weight polymethylenes from CO, H_2 and H_2O.
2,632,015 (Stanolind Oil & Gas Co.) Regeneration of hydrocarbon synthesis catalyst by treatment with ethanol.
2,632,016 (Gulf Research & Development Co.) Multi-bed hydrocarbon synthesis process.
2,632,017 (The Texas Co.) Catalytic synthesis of hydrocarbons.
2,632,316 (The Texas Co.) Separation of carbon dioxide from gaseous mixtures.
2,632,528 (Union Oil Co. of Cal.) Iron-group impregnated adsorbent in adsorption process for separating gases containing CO.
2,632,690 (The Texas Co.) Production of carbon monoxide and hydrogen from hydrocarbons.
2,632,765 (M. W. Kellogg Co.) Separation of organic compounds.
2,633,416-7 (Standard Oil Development Co.) Gasification of carbonaceous solids to produce CO and H_2.

Refining

2,630,191 (Jefferson Lake Sulphur Co.) Cyclic hydrocarbon adsorption process using adsorbent.
2,630,305 (Pan American Refining Corp.) Tower packing (wire fabric).
2,630,374 (Jefferson Lake Sulphur Co.) Method for the recovery of elemental sulfur in liquid form from gases containing hydrogen sulfide and the conversion of the liquid sulfur into solidified flakes.
2,670,375 (Jefferson Lake Sulphur Co.) Method for catalytic desulfurization of gases by oxidation.
2,630,402-3 (Phillips Petroleum Co.) Method of separating and recovering hydrocarbons.
2,630,406 (Universal Oil Products Co.) Method of separating ethyl benzene from xylenes using BCl_3.
2,630,413 (Phillips Petroleum Co.) Pebble heater apparatus and method of regenerating pebbles therein.
2,630,876 (Union Oil Co. of Cal.) Control of gas product streams in adsorption process and apparatus.

To know how good valves can be, install valves that are known to be good





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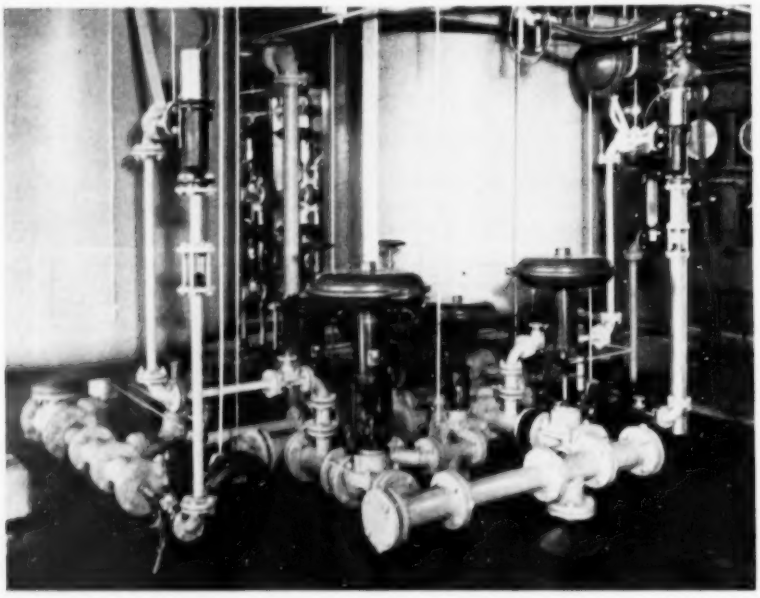
Large midwest corn processor installs SARAN lined pipe, fittings and valves



When one of the largest processors of corn in the midwest was faced with the problem of handling corrosive liquid safely and efficiently in an ion exchange system, they investigated saran lined pipe and fittings.

They learned that saran lined pipe fittings and valves assure tight, leakproof joints. They were convinced that the excellent corrosion resistance of strong, rigid saran lined pipe would mean longer service and greater dependability. The sum total of advantages offered by saran lined pipe indicated that it would meet the company's demands for equipment that would assure uninterrupted processing free from the expense and inconvenience of unscheduled "shutdowns." Wherever piping with unusual resistance to most chemicals and solvents is involved, install saran lined steel pipe. It can be easily cut and threaded in the field without need for special tools or handling; costly downtime can be reduced to a minimum. We'll be glad to assist you with installation plans. Write or call the Saran Lined Pipe Company, Ferndale, Michigan. Offices in New York • Boston • Pittsburgh Tulsa • Philadelphia • Chicago • Portland • Indianapolis • San Francisco Houston • Denver • Los Angeles • Seattle Cleveland • Charleston, S. C. • Toronto Montreal. Saran lined pipe is a product of THE DOW CHEMICAL COMPANY.

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Patents

2,631,087 (Fluor Corp., Ltd.) Sulfur recovery from acid sludge.
2,631,121 (Standard Oil Development Co.) Hypochlorite sweetening process.
2,631,122 (Standard Oil Development Co.) Process for stabilizing catalytically cracked hydrocarbon distillates with caustic in absence of oxygen.
2,631,727 (Gulf Research & Development Co.) Adsorption process for separating liquid mixtures.
2,631,835 (Phillips Petroleum Co.) Heat exchange apparatus for gases.
2,631,921 (Standard Oil Development Co.) Contacting fluid and solids in fluidized bed.
2,631,966 (Socony-Vacuum Oil Co.) Solvent extraction with liquid carbon dioxide.
2,631,969 (Standard Oil Co.-Ohio) Mineral oil treating system using clay.
2,632,002 (Howard H. Gross) Countercurrent slurry process for effecting urea-complex formation.
2,632,030 (Socony-Vacuum Oil Co.) Solvent extraction with carbon dioxide.
2,632,523 (Fluor Corp., Ltd.) Gas separator.
2,632,562 (Clarence H. Dragert) Lead coated container and treating apparatus for sour crude oils.
2,632,720 (Standard Oil Development Co.) Method and apparatus for countercurrent contacting of solids with liquids.
2,632,726 (Phillips Petroleum Co.) Method of guarding selective adsorption separation systems.
2,632,778 (Standard Oil Development Co.) Process for separating naphthenes from paraffin hydrocarbons with silica gel previously contacted with oxy compound.
2,633,207 (Standard Oil Development Co.) Adsorption-fractionation process.
2,633,344 (Societe de'Epuration et d'Entreprises, Societe Anonyme) Mechanical emulsifier for the intimate mixing of a liquid with a gas.
2,633,448 (Pittsburgh Consolidation Coal Co.) Double solvent extraction of oils (naphtha and methanol).

PRODUCTS

Chemicals

2,630,373 (Babcock & Wilcox Co.) Process and apparatus for the thermal synthesis of carbon compounds (carbon disulfide).
2,630,426 (Phillips Petroleum Co.) Treatment of rosin soaps, and use of resulting soaps in emulsion polymerization.
2,630,430 (Shell Development Co.) Allyl alcohol-styrene copolymers.
2,630,438 (Universal Oil Products Co.) Drying oil compositions.
2,630,456 (Shell Development Co.) Preparation of tert. butyl hydroperoxide from alcohol.
2,630,460 (Universal Oil Products Co.) Production of a 4-alkylbiphenyl.
2,630,461 (Hans Sachsse, et al) Production of acetylene by incomplete combustion of hydrocarbons.
2,631,084 (Phillips Petroleum Co.) Ammonium sulfate production.
2,631,125 (Diamond Alkali Co.) Stabilization of chlorinated paraffin wax with polyhydroxy compounds.
2,631,138 (Shell Development Co.) Curing resin-forming compositions with sulfonic acids.
2,631,139 (Standard Oil Development Co.) Diolefin copolymer rubber plasticized with tough styrene-isobutylene copolymers.
2,631,140 (Universal Oil Products Co.) Modified phenolic resins.
2,631,142 (Polymer Corp. Ltd.) Catalyst activator for diolefin polymerization.
2,631,160 (Universal Oil Products Co.) Oxidation of unsaturated hydrocarbons in acid solution.
2,631,161 (Universal Oil Products Co.) Manufacture of dimethylhydrogen phosphite.
2,631,166 (E. I. du Pont de Nemours & Co.) Method for separating reaction products obtained by reaction between propylene and aqueous ammonium polysulfide.
2,631,170 (USA) Process for the preparation of fluorocarbons.
2,631,173 (Phillips Petroleum Co.) Production of cyclooctadiene.
2,631,172 (Universal Oil Products Co.) Preparation of aryl haloalkanes.
2,631,174 (Universal Oil Products Co.) Production of polycyclic benzene hydrocarbons.
2,631,175 (Phillips Petroleum Co.) Production of liquid poly-butadiene.
2,631,176 (Standard Oil Development Co.) Production of high viscosity olefin polymers.
2,631,953 (Standard Oil Development Co.) Bonding isoolefin-diolefin rubber to metal by an isoolefin-styrene-diolefin resin and a modified natural rubber tie ply.
2,631,970 (Stanolind Oil & Gas Co.) Method for purification of alcohols containing oxidizable impurities.

Patents

2,631,980 (California Research Corp.) Noncaking alkyl aryl sulfonate detergent compositions.
2,631,996 (Pan American Refining Corp.) BF_3- iodine polymerization of unsaturated hydrocarbon mixtures.
2,632,021 (Standard Oil Development Co.) Esterification process utilizing added unsaturated acids.
2,632,026 (Hercules Powder Co.) Oxidation of aromatic hydrocarbons.
2,632,027 (Phillips Petroleum Co.) Production of phenolic compounds by oxidation of hydrocarbons.
2,632,689 (Phillips Petroleum Co.) Process and apparatus for effecting chemical reactions (making HF).
2,632,756 (Shell Development Co.) Olefinic tetraesters of bis (phosphonoalkyl) * ethers and their polymers.
2,632,771 (Phillips Petroleum Co.) Urea synthesis.
2,632,774 (Hercules Powder Co.) Oxidation of aromatic hydrocarbons.
2,632,777 (Universal Oil Products Co.) Production of hydrocarbon conjunct polymers.
2,632,779 (Standard Oil Development Co.) Production of paraxylene.
2,633,411 (Joseph J. Ferrainolo) Portable apparatus for analyzing gases.
2,633,458 (Shell Development Co.) Sulfur-containing resinous products from polyepoxides.
2,633,475 (Standard Oil Development Co.) Catalytic dehydrogenation of secondary alcohols to ketones.
2,633,476 (Shell Development Co.) Production of aromatic hydroperoxides.
2,633,477 (Standard Oil Development Co.) Catalytic method and apparatus.

Fuels

2,630,405 (Shell Development Co.) Fuel obtained by separate treatment of distillates with urea and thiourea.
2,631,929 (Standard Oil Development Co.) Stabilizing vanadium containing fuel oils with halogen compound.
2,632,031 (Phillips Petroleum Co.) Production of isooctanes from cyclopropane and isobutane.
2,632,296 (Eugene J. Houdry) Process of generating power involving catalytic oxidation.
2,632,696 (Gulf Oil Corp.) Stabilized hydrocarbon fuel oils; containing aldehyde-aniline reaction product.
2,633,415 (Universal Oil Porducts Co.) Stabilization of gasoline with quaternary ammonium alkoxide, etc.
2,633,425 (Universal Oil Products Co.) Stabilization of organic compounds with hydroxy amino dihydronaplithalene.

Lubricants

2,631,129 (Tide Water Associated Oil Co.) Sulfurized tall oil-containing compositions (for cutting oils).
2,631,130 (Standard Oil Development Co.) P-S reacted material as mineral oil additive.
2,631,131 (Tide Water Associated Oil Co.) Stabilized compositions containing sulfurized esters of tall oil.
2,631,132 (Standard Oil Development Co.) P-S compound as lubricating oil additive.
2,632,347 (Standard Oil Development Co.) Emulsifiable lubricant for metal rolling mills.
2,632,734 (Standard Oil Development Co.) Emulsifiable metalworking lubricant containing sulfonate.
2,632,735 (Standard Oil Development Co.) Lubricating oil additives containing S-Cl.
2,632,767 (Standard Oil Development Co.) Complex phosphate ester synthetic lubricant.
2,633,471 (Standard Oil Development Co.) Pour point inhibitor by heating stearic acid in presence of steel wool.

Specialties

2,630,368 (Shell Development Co.) Vapor phase inhibitors of corrosion (heterocyclic base).
2,630,380 (The Dow Chemical Co.) Corrosion inhibition with dinitro alkyl phenol.
2,631,107 (Phillips Petroleum Co.) Process of preparing carbon black containing substantial amounts of sulfur.
2,631,979 (Standard Oil Development Co.) Rust inhibiting composition containing polymerized linoleic acid.
2,632,694 (Sinclair Refining Co.) Petroleum distillates containing ammonium mahogany sulfonates and oil soluble carboxylic acids to prevent corrosion.
2,632,695 (Socony-Vacuum Oil Co.) Rust inhibitor for light petroleum products and containing dimeric and trimeric acids.
2,632,709 (Shell Development Co.) Oxidized wax rust inhibiting composition.
2,632,712 (Standard Oil Co.-Ind) Asphalt composition.
2,632,713 (Phillips Petroleum Co.) Carbon black process.

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Extra-Utility Pipe Vises

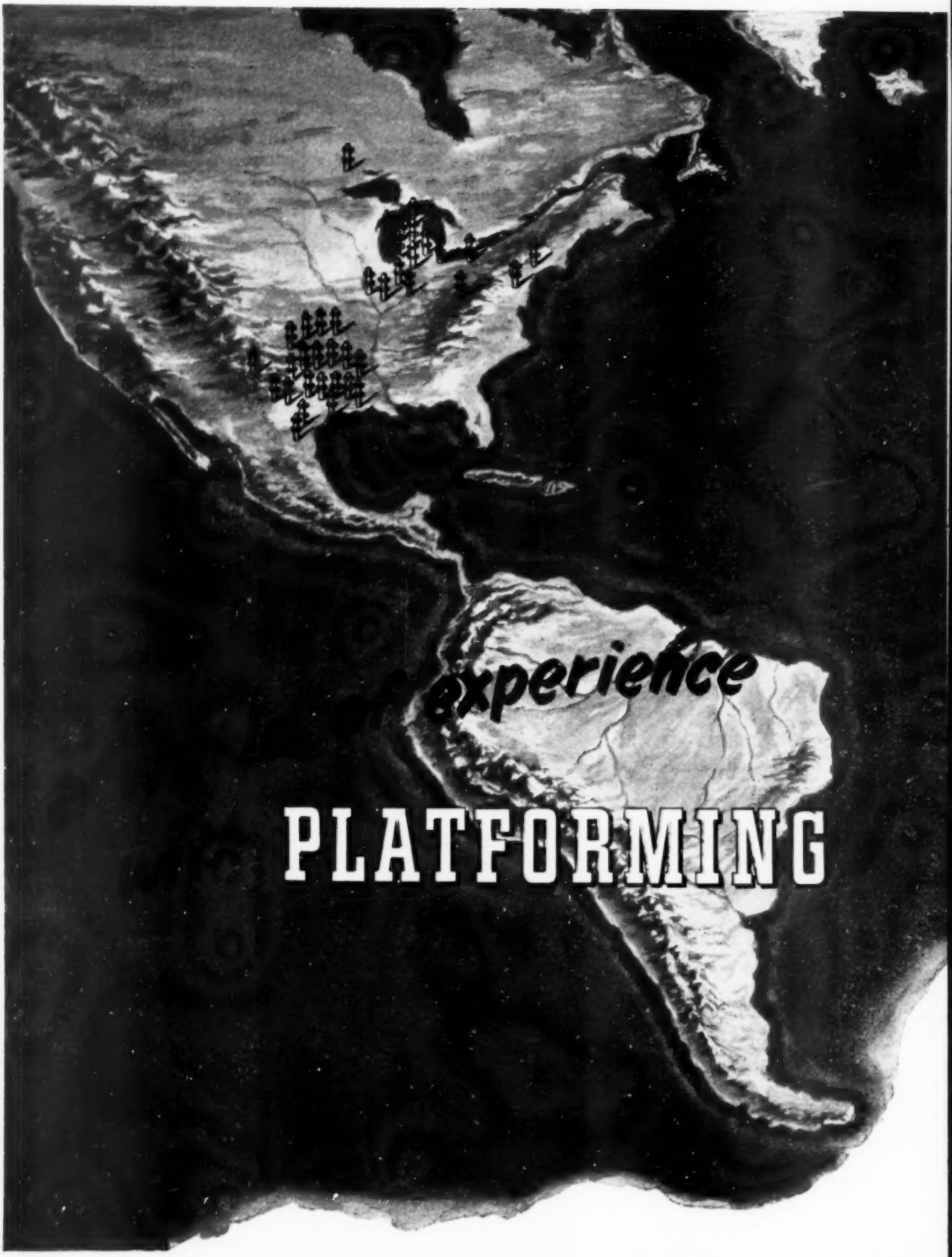
Compare those work-saver RIDGID Vises with any others and you see the bonus of extra utility you get for your money. Kit vise is easily toted to the job, quickly clamped on edge of bench or plank, ready to use. All other RIDGID vises have handy integral pipe benders and rests to make cutting and threading easier. Full-width firm-gripping jaws of top quality tool-steel, bodies of rugged special malleable—for years of service. 9 models, yoke and chain, 23 sizes, meet every need. Get your money's worth—buy RIDGID Vises at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

RIDGID

Work-Saver Pipe Tools

(To obtain more data on advertised products see page 768)



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52 UNITS — 21 on stream . . . 31 in design or under construction — a total of 39 in the U. S. A. . . . four in Japan . . . two each in Great Britain, Australia and the Middle East . . . one each in Canada, Canary Islands, and France. That's how far PLATFORMING has come since October 27, 1949 when the first unit went on stream at Muskegon, Mich.

Refiners all over the world have chosen PLATFORMING because it is the proved solution to their reforming problems . . . because it produces high octane fuel from low grade charge stocks . . . because it has the aromatics option . . . because it is versatile, economical, and dependable! You can rely on this world-wide experience in making *your* choice.

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your ***Investment***

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BLACKMER
LIQUID MATERIALS HANDLING

HAND PUMPS

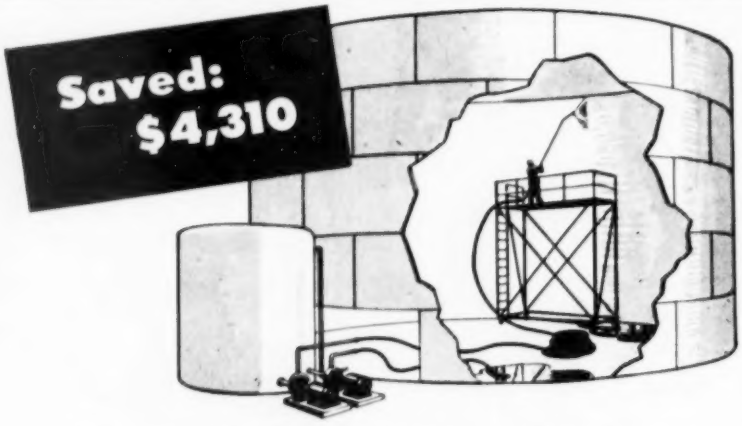
. . . for clean, fast liquid handling

Dispense light or viscous petro-chemicals from drums, wheel tanks or underground storage. Control hazardous liquids. Stop waste.

RUGGED CONSTRUCTION

Outlasts lightweight pumps. Built for industrial service. Low cost. Available in many models and with wall and base mounting accessories.

BLACKMER PUMP COMPANY • GRAND RAPIDS, MICHIGAN



Storage Tank Cleaned by Own Crew

That's the report from a Southwestern refiner. An 80,000 barrel tank thoroughly cleaned, even around rivet heads, in 12 hours, at a cost of only $490. Previous cost was $4800. Saving: $4310.

The cleaning is simple. He just sprays an Oakite solvent detergent on tank sides and supporting columns, then follows up with a high pressure rinse. No scraping—no steaming out.

That's the kind of simplicity and economy you get with Oakite solvent detergents. They clean cold, remove tough soils without affecting paint, have long-lasting cleaning power.

FREE BOOKLET gives details; tells how to save time and money on tough cleaning jobs. Get your copy today. Write Oakite Products, Inc., 50D Rector St., N. Y. 6, N. Y.

Technical Service Representatives Located in Principal Cities of United States and Canada

OAKITE
PETROLEUM SERVICE DIVISION

Patents

2,633,418 (Shell Development Co.) Herbicidal composition and method of weed control, based on aromatic oil.

Miscellaneous

2,630,968 (Gulf Research & Development Co.) Electrical calculator for solving phase equilibrium problems.
2,631,015 (Shell Development Co.) Continuous helical liner for vessels.
2,632,432 (Standard Oil Co.-Ohio) Internal-combustion engine.
2,632,466 (Standard Oil Development Co.) Storage tank construction.

EQUIPMENT

Processing, general

2,630,877 (Union Oil Co. of California)—Adsorption process and apparatus for separating a gaseous mixture.
2,631,022 (Hudson Engineering Corp.)—Vertical cooling tower.
2,631,091 (Standard Oil Co.)—Apparatus for contacting separate phases at controlled temperature and high pressure.
2,631,614 (The Fluor Corp.)—Gas stream pulsation dampener.
2,631,828 (The Fluor Corp.)—Liquid and gas contacting apparatus.
2,631,927 (Shell Development Co.)—Apparatus for removal of carbonaceous deposits from powdered solids.
2,632,314 (Phillips Petroleum Co.)—Fractional fusion apparatus.
2,632,501 (Peabody Engineering Corp.)—Fluid fuel burner.
2,632,503 (Standard Oil Development Co.)—Tubular radiant gas burner.
2,632,638 (Hudson Engineering Corp.)—Gas and liquid contact apparatus.
2,632,733 (Carroll P. Sherwood)—Water purification process and apparatus.
2,633,294 (Aktiebulaget Separator) — Method and apparatus for centrifugal separation.
2,633,454 (Standard Oil Development Co.)—Apparatus for manufacture of microspheroidal gel beads.
2,633,472 (Petrolite Corp.)—Reagent control method and apparatus.

Catalytic Reactors

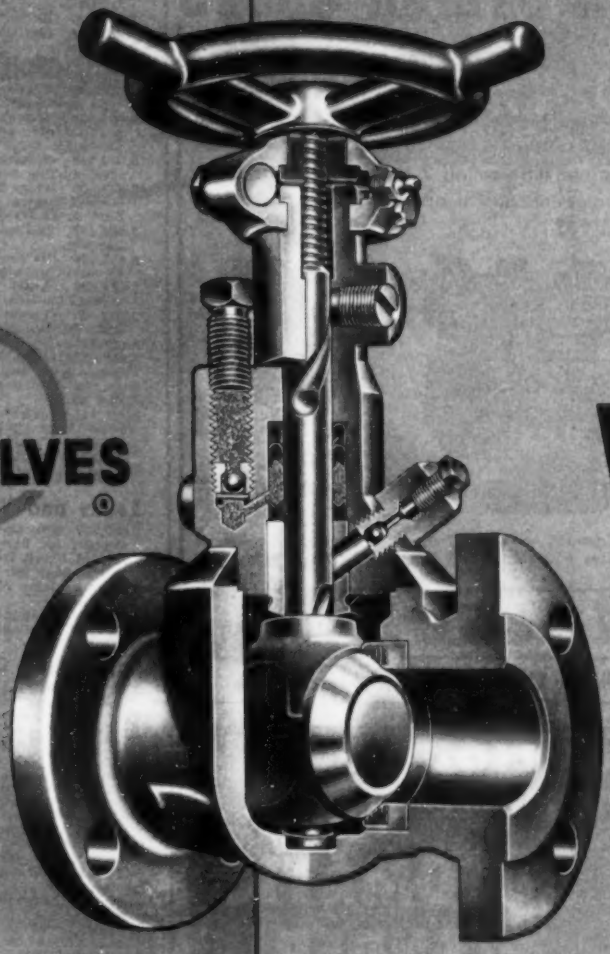
2,630,352 (M. W. Kellogg Co.)—Means for handling powdered solids.
2,631,090 (Standard Oil Development Co.)—Catalytic conversion apparatus.
2,631,123 (Standard Oil Development Co.)—Process and apparatus for hydrating cracking catalyst.
2,631,928 (Sinclair Refining Co.)—Catalytic cracking apparatus.
2,632,692 (Hydrocarbon Research, Inc.) — Multiple bed catalyst apparatus.
2,632,720 (Standard Oil Development Co.)—Method and apparatus for counter-current contacting of solids with liquids.
2,633,477 (Standard Oil Development Co.)—Method and apparatus for accomplishing catalytic reaction of reactant vapor.

Instruments

2,630,007 (The Foxboro Co.) — Electrical measuring apparatus, including a condition responsive impedance.
2,630,008 (The Foxboro Co.) — Electrical measuring apparatus, including a condition responsive impedance.
2,630,009 (Loraine E. Hebl)—Combustion severity indicator for internal combustion engine.
2,630,010 (Imperial Chemical Industries Ltd.) —Liquid gravitational meter.
2,630,042 (Minister of National Defence, Canada)—Differential refractometer for measuring differences between refractive indices of two liquids.
2,630,140 (Mason-Neilan Regulator Co.)—Fluid-pressure diaphragm motor for control valves and the like.
2,630,715 (Rochester Mfg. Co., Inc.)—Liquid level gage.
2,630,736 (American Optical Co.)—Spectrophotometer.
2,630,819 (Austin S. Norcross)—Method and apparatus for processing liquid viscosity.
2,630,820 (American Meter Co.)—Gas metering system control.
2,630,824 (Minneapolis-Honeywell Regulator Co.)—Proportional speed floating air control apparatus.
2,630,968 (Gulf Research & Development Corp.)—Electrical calculator for solving phase equilibrium problems.
2,631,027 (The Sharples Corp.) — Force measuring apparatus for determining particle size distribution of finely divided material.

No DANGEROUS Fluid Traps!

ORBIT VALVES ®



No... VOIDS

ORBIT Forged Steel LP GAS VALVES are designed to safely handle hydrocarbons.

BRANCHES

HOUSTON, TEXAS
407 Velasco
(Serving the Gulf Coast)

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Trapped fluids become a contingent danger in case of fire. The body of an Orbit Forged Steel Valve is void of any areas where fluid could be trapped when the Valve is closed or open.

Your Supply Store carries ORBIT Forged Steel LP GAS VALVES. Sizes 1" to 4" ASA Class. Maximum Rated Working Temperature 250° Fahrenheit. Screwed and Flanged Ends.

ORBIT VALVE COMPANY

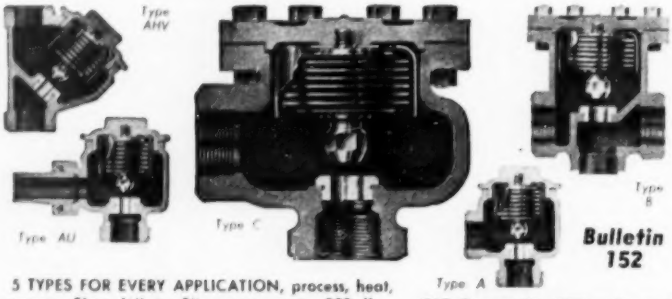
P. O. BOX 699 TULSA, OKLA.

In This Plant Nicholson Traps

SAVED 10% IN STEAM COSTS

Chief Engineer H.F.D. stated, after Nicholsons replaced mechanical traps in his plant: "Saving in steam waste cut our fuel cost at least 10%. Yet application temperatures were up 30°-40°. And relief of all air binding effected faster warm up."

Operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air venting. For other advanced Nicholson features send for Bulletin 152.



Bulletin 152

5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes ¼" to 2"; pressures to 250 lbs.

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W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

FOR BLENDING LIQUIDS
You can't beat the accuracy of a . .

BOWSER ESTABLISHED 1885

AUTOMATIC *BLENDER!

*THE BLENDER THAT USES XACTO—the world's most widely used meters!

Actual operating records prove that use of the Bowser Automatic Blender results in constant formula accuracy to 1/10 of 1%.

If you blend or mix two or more liquids, chances are the Bowser engineer in your vicinity can show you how to increase production, cut costs and assure product uniformity. Call him TODAY!

Write for the new folder on Automatic Blending Systems

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REGIONAL OFFICES: ATLANTA • CLEVELAND • DALLAS FORT WAYNE • KANSAS CITY • NEW YORK • SAN FRANCISCO • WASHINGTON, D. C. • HAMILTON, ONTARIO

Patents

2,631,088 (Lloyd V. Guild)—Apparatus for making gas analyses.
2,631,378 (Robert John Wynne)—Internal gage.
2,631,570 (The Foxboro Co.)—Electric controller.
2,631,925 (Barber & Co.)—Measuring apparatus for continuous analysis of oxygen and hydrogen.
2,632,110, 111, 112, and 113 (Consolidated Engineering Corp.)—Mass spectrometer.
2,632,329 (Taylor Instrument Co.'s.)—Vane type flowmeter.
2,632,330 (Evershed & Vignoles, Ltd.)—Apparatus for indicating the displacement of an object from a datum position.
2,632,419 (Eugene Topping)—High and low level audible boiler water alarm.
2,632,456 (Harry B. Breedlove)—Variable ratio control apparatus for adjusting relation of fluid pressures.
2,632,457 (Edward H. Paulsen) — Liquid sampling.
2,632,474 (Barton Jones) Dampener for differential pressure indicators.
2,632,634 (Brush Development Co.)—Electro-acoustic device.
2,632,825 (Perfex Corp.) — Temperature responsive switch.
2,633,021 (U. S. A.)—Liquid level indicator.
2,633,022 (Republic Flow Meters Corp.)—Liquid level measuring apparatus.
2,633,026 (Valentine Bautista)—Mercury pressure gage.
2,633,411 (Joseph J. Ferrainolo)—Portable apparatus for analysing gases.
2,633,509 (Ernest E. Fields, Frank A. Jova, Frank P. Librizzi)—Material level control means for feed hoppers.

Tanks and Vessels

2,630,937 (Chicago Bridge & Iron Co.)—Seal support for floating roof tanks.
2,631,015 (Shell Development Co.)—Continuous helical liner for vessels.
2,631,093 (John W. Wiggins) Gas storage apparatus.
2,632,466 (Standard Oil Development Co.)—Storage tank construction.

Pumps and Compressors

2,630,266 (National Research Corp.)—Oil diffusion pump.
2,630,759 (Thomas E. Mahlon)—Variable volume rotary gear pump.
2,631,050 (Worthington Corp.) — Automatic shut down seal system for centrifugal compressors.
2,631,543 (Standard Oil Development Co.)—Packless impeller pump.
2,631,544 (Technical Instrument Laboratory)—Rotary vane pump.
2,631,545 (Lester V. Jones, John D. Dalton)—Vertical high pressure pump.
2,631,546 (Edward A. Dawson)—Rotary sliding vane pump.
2,631,774 (Ingersoll-Rand Co.) — Thermocompressor.
2,632,395 (Phillips Petroleum Co.)—Heat exchange assembly for centrifugal pumps.
2,633,290 (Henry G. Schaefer, Phillip Baumeister) — Vacuum pump with expanding liquid spiral.
2,633,291 (Dresser Operations, Inc.)—Centrifugal gas compressor.
2,633,292 (Karel Voznica)—Rotary compressor for gas or liquids.

Valves and Fittings

2,630,294 (American Car & Foundry Co.)—Lubricated valve with lubricated vent.
2,630,818 (Fred W. McRae)—Temperature released check valve.
2,630,920 (Ralph L. Kerr) — Combination strainer and check valve.
2,631,001 (Taylor Instrument Co.'s)—Flow diversion valve.
2,631,605 (Manning, Maxwell & Moore, Inc.)—Spring loaded safety valve.
2,631,606 (Asbury S. Parks)—Fluid pressure regulator.
2,631,612 (General Controls Corp.)—High pressure fluid valve.
2,631,759 (Sinclair Refining Co.)—Slide valve for controlling flow of suspended solids.
2,633,326 (R. O. Stekoll)—Stopcock valve.
2,633,386 (Frank D. Mahoney)—Combination nozzle, check valve and strainer.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

Hooker Chemical Guide
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USE this handy reference to save time in selecting high quality chemicals.

HOOKER
ALUMINUM CHLORIDE
ANTIMONY TRICHLORIDE

ALUMINUM CHLORIDE

Formula: $AlCl_3$
Form: Anhydrous gray crystalline solid, supplied in four standard sizes
Molecular Weight: 133.3

PROPERTIES

Aluminum Chloride (Sublimables in air at 950°C.)	98.5% Min.
Iron	0.05% Max.
Heat of Solution	550 small cal/gm

SCREEN SIZES

Extra Fine Grind—An unscreened material, 90 to 95% passing 40 mesh.

Fine Grind—An unscreened material, practically all passing 20 mesh.

Coarse Grind—An unscreened material, 1 mesh and finer, containing 25 to 35% finer than 20 mesh.

Coarse Screened—Same as coarse grind, screened to remove 20 mesh and finer.

USES

Catalyst: For Friedel-Crafts synthesis, isomerization, alkylation, polymerization, halogenation.

End Products: Plastics, resins, high octane gasoline, lubricants, lube additives, synthetic rubber, dyes, photographic chemicals, pharmaceuticals, etc.

Fluxing Agent: For aluminum refining and aluminum casting.

ANTIMONY TRICHLORIDE

Synonym: Antimonous chloride
Formula: $SbCl_3$
Form: Anhydrous yellowish solid
Molecular Weight: 228.1

PROPERTIES

Antimony Trichloride	99% Min.
Iron and Arsenic	1% Max.
Lead	0%
Melting Point	73.4°C

USES

Catalyst: Dyes, pharmaceuticals, petrochemicals.

Antimony Salts: Mordant in cotton printing.

Metal Treating: Antimony plating, bronzing.

For detailed information on items listed, drop us a note on your letterhead. Address your request to HOOKER ELECTROCHEMICAL COMPANY, 4713 Buffalo Ave., Niagara Falls, New York.

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HOOKER ELECTROCHEMICAL COMPANY
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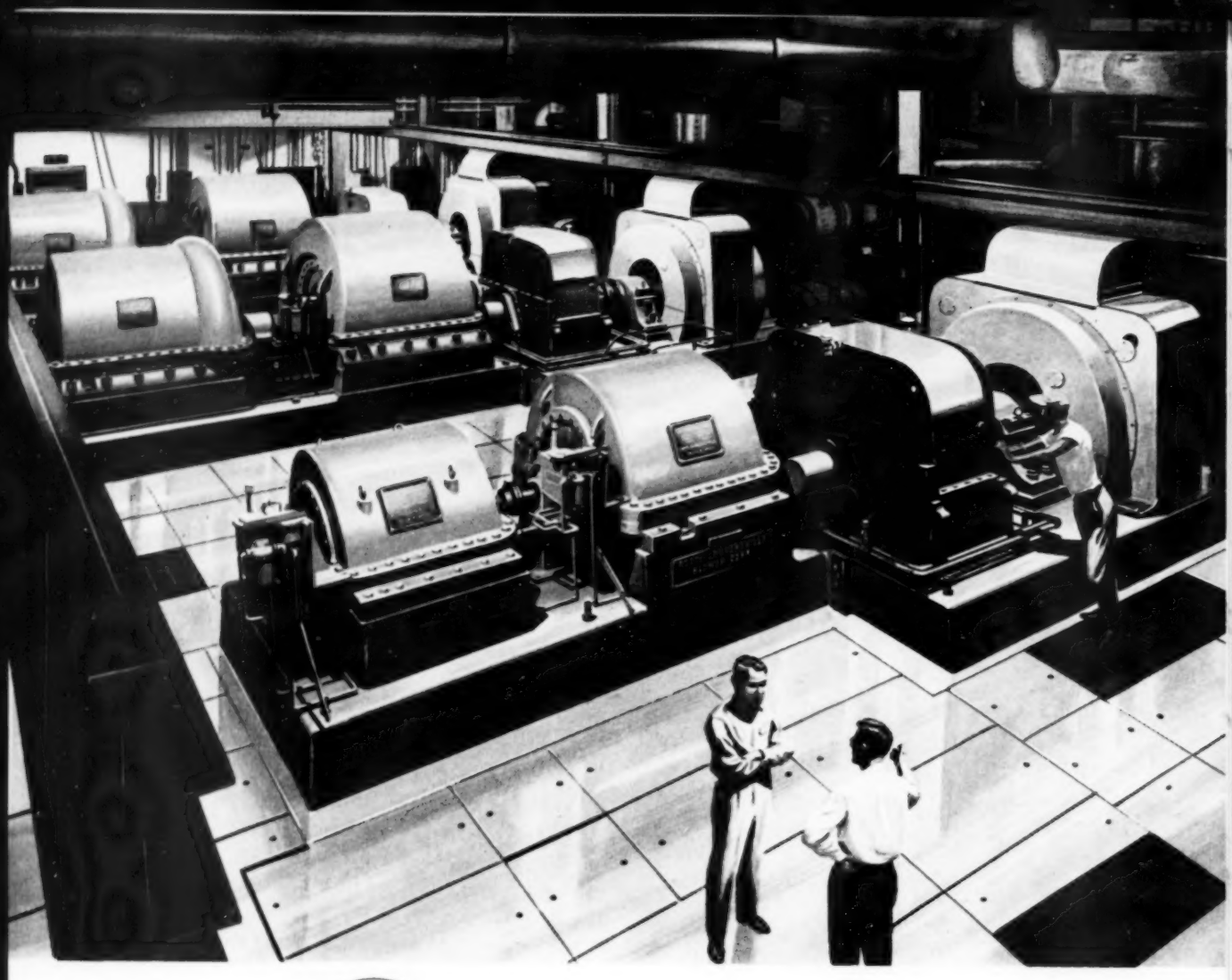

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In the movement of gas and air under moderate pressures, the oil and gas industries look to the acknowledged pioneer in this field, the Roots-Connersville Blower Division of the Dresser Industries. Serving almost every branch of industrial activity, Roots-Connersville continues today a tradition of leadership begun in 1854.

Magnet Cove Barium Corp., *Houston, Tex., Malvern, Ark., Greybull, Wyo.* Magcobar drilling mud, Magcogel bentonite, Mylojel, Fiber Seal, Jel-Oil mud.

Clark Bros. Co. Division, *Olean, New York.* Engines and compressors—gas, steam and diesel driven.

Dresser Manufacturing Division, *Bradford, Pa.* Oil and gas and pipe couplings, fittings and sleeves—rolled and welded rings—welding fittings and flanges.

Kobe, Inc., Division, *Huntington Park, Calif.* Complete hydraulic oil field pumping systems, including the Kobe Free Pump.

No. 8 in a series about Dresser Industries

What is

DRESSER INDUSTRIES

Dresser Industries, Inc. is one company—with the strength of many! A joint endeavor dedicated to producing the finest of integrated equipment and coordinated service for the oil, gas and chemical industries.

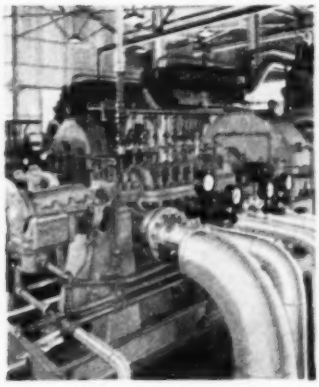
Each member company is an individual specialist and leader in its field. The parent, Dresser, incorporates many added services into its over-all administration, yet each company retains its individual identity and management. Such an integrated organization derives economies that are passed on to the operator along with the many other advantages of the specialized experience, know-how, research and development of each of these operating companies.

Dresser Industries is a vigorous, competent, far-reaching team to help meet efficiently the world's ever expanding energy requirements—a service unlimited—that makes your job easier, faster, more productive. This is your dividend from these combined operations—the DRESSER PLUS +

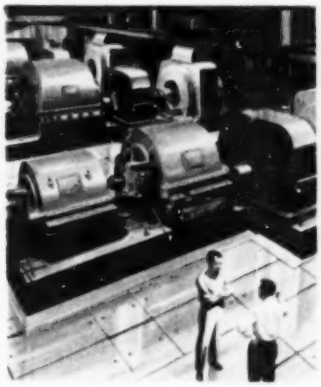
With its dual-ability line of both rotary positive and centrifugal blowers and exhausters, and an extensive range of gas and vacuum pumps, rotary positive displacement meters and inert gas generators, Roots-Connersville brings almost a century of specialized experience to industry's problem of moving gas and air.

DRESSER INDUSTRIES, INC.
OIL, GAS AND CHEMICAL EQUIPMENT

ATLANTIC BUILDING ★ DALLAS, TEXAS

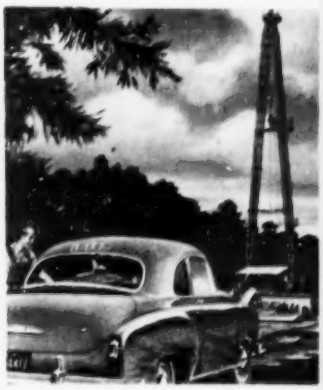


Pacific Pumps, Inc., *Huntington Park, Calif.* Centrifugal pumps, deep oilwell plunger pumps, hot oil and boiler feed pumps.

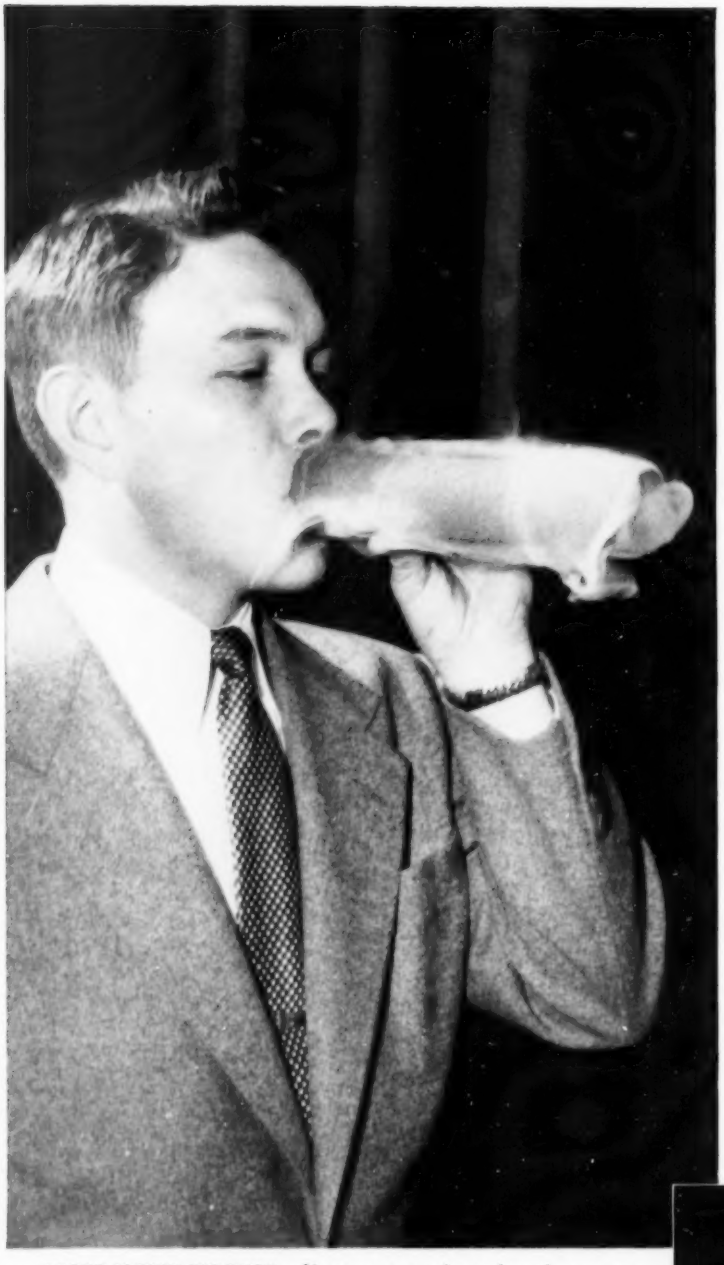


Roots-Connersville Blower Division, *Connersville, Ind.* Rotary positive blowers, gas pumps; centrifugal blowers, exhausters; positive displacement meters.

Security Engineering Division, *Whittier, Calif., Dallas, Tex.* Rock bits, reamers, casing scrapers, reamer rock bits, coring bits, Securalov.



Ideco Division, *Dallas, Beaumont, Tex.* Derricks, drawworks, rambler drilling rigs, traveling blocks, rotary tables.



SMOKE BLOWN THROUGH a Norton ALUNDUM* *seamless* tube escapes throughout the tube's entire area. Such a tube gives most efficient filtration and ease of cleaning by back washing. When selecting tubes for your specific application be sure they embody this important feature.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

Why Norton seamless tubes give you better filtration

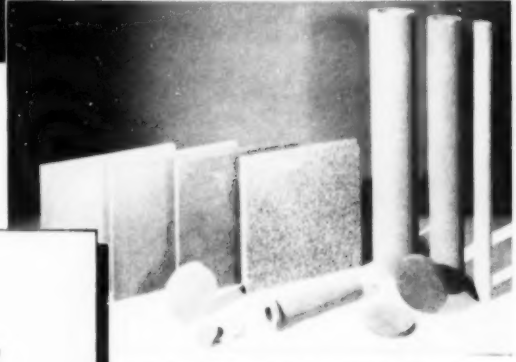
Only Norton ALUNDUM tubes have the seamless construction that means more uniform filtration and enables faster, more thorough cleaning. And like all Norton porous mediums they're made with the patented *controlled structure* process that assures even distribution of pores — in the size and open-pore ratio that best meets your needs.

Cost-cutters over a wide job range

In any form, Norton porous mediums have exceptional resistance to breakage, chipping and acid and alkaline conditions. They're designed to perform better, last longer and cut your operating costs in a wide variety of chemical field applications. For example: filtering water or solvents . . . cutting oils, wine and other liquids . . . reclaiming cleaning fluids and industrial waste . . . in boiler feed water treatment.

Get the whole story

See your Norton Representative for complete facts on how you can get more savings and satisfaction with Norton porous mediums. Or write describing your requirements, to NORTON COMPANY, 264 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.



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Making better products to make other products better

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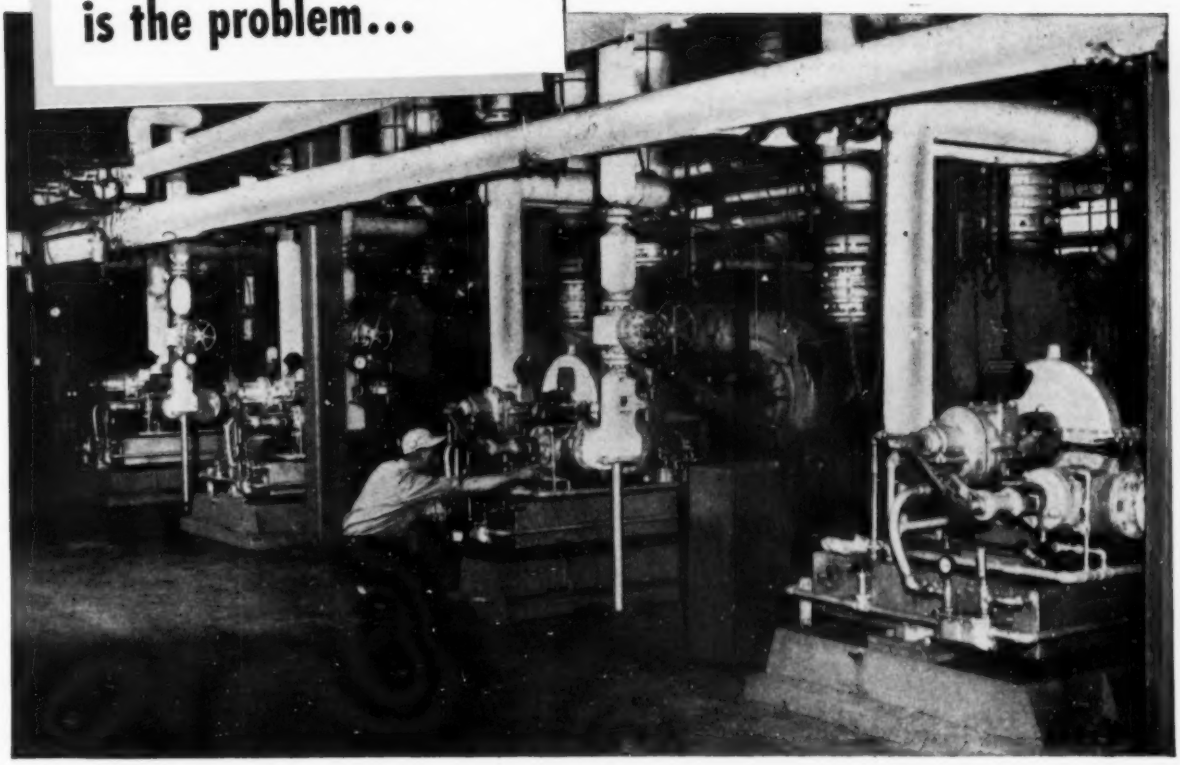

TYPE E gearturbines can handle it!

Process requirements in the evaporator room of the Masonite Plant, Ukiah, California, called for a variable-speed pump drive to provide for fluctuating load conditions. Steam was available. In the words of this user: "Westinghouse Type E, Close-coupled Gearturbines were selected since the pumps had to operate at relatively low speeds, and the higher efficiency inherent in the high-speed turbines was desirable. In operating performance, these turbines have proved the most efficient and economical solution to our problem."

Also in the evaporator room, the Masonite Company selected four Westinghouse Type E Turbines to drive the boiler feed pumps. These turbines provide an efficient, trouble-free drive which can be driven by the existing steam supply. Motor-driven units are used as stand-bys.

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Wrapped up in a single package is a compact, rugged, and reliable speed-reduction unit solidly coupled to a Type E turbine. Each gearturbine is mounted on an extremely rugged base, fabricated of heavy steel plate which forms the oil reservoir. This arrangement simplifies mounting and installation. It provides operating stability never before available.

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TYPE E Turbines

WELLSVILLE, NEW YORK. Sinclair Refining Company's new propane deresining unit at the Wellsville refinery, performs the dual role of removing undesirable asphaltic material from high quality Pennsylvania Grade lubricating oil and recovering heavy resins used in the manufacture of wax-coated paper and other everyday items. Fluor engineered and erected this plant on schedule and possesses the experience and ability to build processing units, large or small, anywhere in the world – not only for the refining industry but for natural gas, chemical, petrochemical, power and heavy industries as well.

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1953 HANLON AWARD winner Darst E. Buchanan (left) is presented with his medal by John F. Lynch, president of the National Gasoline Association of America at that group's 32nd annual convention in Houston's Rice Hotel late last month. Mr. Buchanan, president of the Hiwan Oil & Gas Co., is the 17th recipient of the Award, given annually by NGAA for outstanding service to the natural gasoline and cycling industries.

Dr. Frederick D. Rossini, Silliam Professor, chemistry department head and director of the American Petroleum Institute research laboratory at Carnegie Institute of Technology, will present the 27th Edgar Marburg Lecture at the annual meeting of the American Society for Testing Materials, June 29-July 3 in Atlantic City.

The lecture, given at each annual ASTM meeting, originated as a testimonial to the first secretary of the Society, and was established to emphasize the importance of furthering knowledge on properties and tests of engineering materials.

Dr. Rossini delivers his talk on Wednesday afternoon, July 1. He will outline fundamental research in petroleum chemistry, discussing projects supported cooperatively by industry through the American Petroleum Institute, paying particular attention to API research projects covering composition of crude petroleum.

An authority in physical chemistry, Dr. Rossini has a broad background as an educator, lecturer, scientist and author, with years of service as a member of ASTM Committee D-2 on Petroleum Porducts. In 1946 he was elected president of the Commission on Thermochemistry of the International Union of Pure and Applied Chemistry, having been nominated in 1934 as U. S. member of this Commission. He is author or coauthor of approximately 150 scientific papers dealing with thermochemistry and hydrocarbons.

* * *

H. W. Anderson has been appointed chief research chemist and **R. A. Burdett** has been appointed to the new position of chief research physicist at Shell Oil Co.'s Wood River, Ill. research laboratory.

Dr. Anderson formerly held the same position at Shell's Martinez, Calif. refinery. He graduated from the University of Minnesota in 1938 and received his PhD from the University of California in 1941. He joined Shell as a technologist in San Francisco in 1943, later transferring to the Martinez laboratory. In 1947 he was shifted to the cracking department there and returned to the laboratory in 1949.

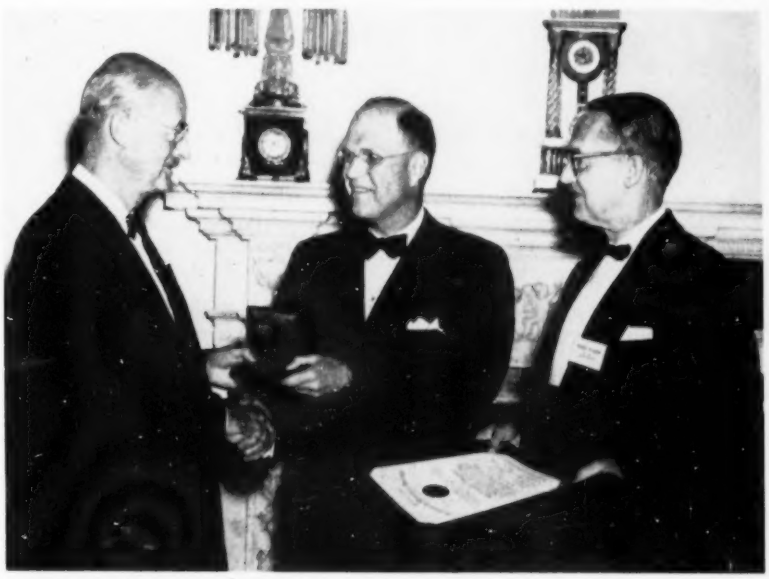
Mr. Burdett is a graduate of Cornell University and received his MA in chemistry at Harvard. He came to Wood River as a junior research chemist and by 1947 was assistant chief research chemist. In 1950 he transferred to New York, returning to the Shell Illinois location the following year.

* * *

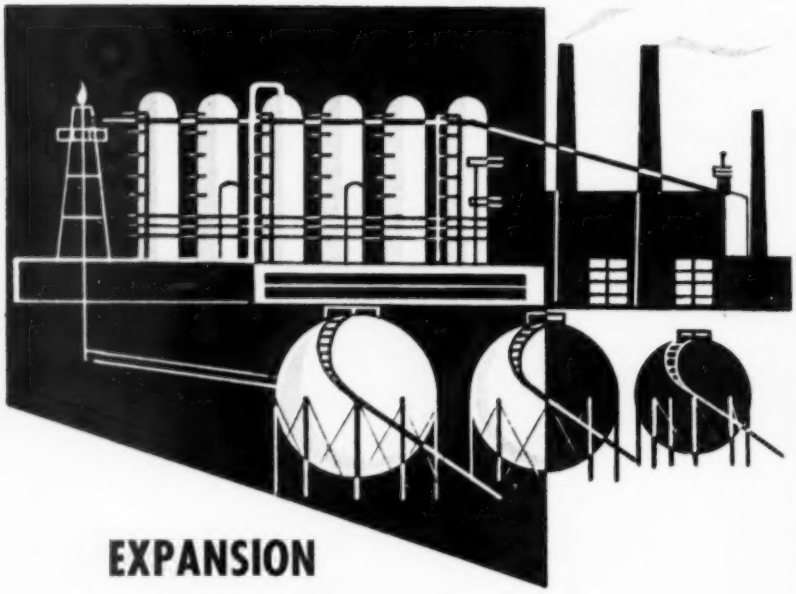
Dr. Charles L. Thomas has been named Sun Oil Co. associate research and development director in charge of all line activities. His headquarters are to be at Marcus Hook, Pa., where Sun is currently building additional laboratories. He was previously manager of the firm's Norwood, Pa. research lab.

Three newly-created staff positions as assistant directors will be filled by **Norman Thompson,** formerly assistant superintendent of the Marcus Hook refinery; **John G. Moxey, Jr.,** formerly manager of the automotive laboratory; and **James I. Harper,** formerly chief of the process development section, development laboratory. All three assistant directors will have headquarters with the present director, **Dr. J. Bennett Hill,** in Sun's Philadelphia offices.

Several other new appointments



FOR "INSPIRING LEADERSHIP" Dr. Eger V. Murphree (center), president of Standard Oil Development Co., was awarded the Industrial Research Institute's 1953 Medal during the group's 15th annual meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., in April. Presenting the medal is Dr. H. N. Stephens (left), vice president of the Institute and director of research, Minnesota Mining and Mfg. Co. Dr. Fred Olsen (right), Institute president and vice president, research and development, Olin Industries, Inc., holds the accompanying citation.



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have been made in connection with creation of new department divisions: **W. Herman Barcus** to manager of a new products development division, Marcus Hook, from manager of the development laboratory; **Earl M. Heneycutt** to manager of the new process development division, Marcus Hook, from the process development section, development laboratory; **Dr. Robert M. Kennedy** to manager, basic research division, Norwood, from the research laboratory; **Stewart S. Kurtz, Jr.,** to manager of the analytical division, Marcus Hook; and **William A. Casey** to manager, technical service division, Marcus Hook, from chief, technical service section, development laboratory.

* * *

Frank W. Bowen has been appointed superintendent of the Sun Oil Co. refinery now under construction at Sarnia, Ontario, Canada. Formerly chief chemical engineer at Sun's Toledo, Ohio refinery, he will supervise plant operations under the direction of plant manager Gordon R. Henderson.

Mr. Bowen

Mr. Bowen joined Sun Oil at its Marcus Hook, Pa., refinery after completing graduate work on a chemical engineering degree at Cornell in 1939. Serving in the development division for two years, he was transferred to Sun's general office in Philadelphia and promoted to process engineer. He has been at the Toledo refinery since 1944.

* * *

J. G. Woods has been appointed director of operations of Mathieson Chemical Corp.'s Hydrocarbon Chemicals Division. He will be responsible for supervision of Division plants at Doe Run, Ky., and Niagara Falls, N. Y. Joining Mathieson in 1950, he headed the group which designed and engineered the Doe Run petrochemical plant, where he later became manager. Prior to joining Mathieson, he was superintendent of Dow Chemical Co.'s ethylene plant at Freeport, Texas.

Mr. Woods

Llewellyn S. Howe replaces Mr. Woods as Doe Run manager. He

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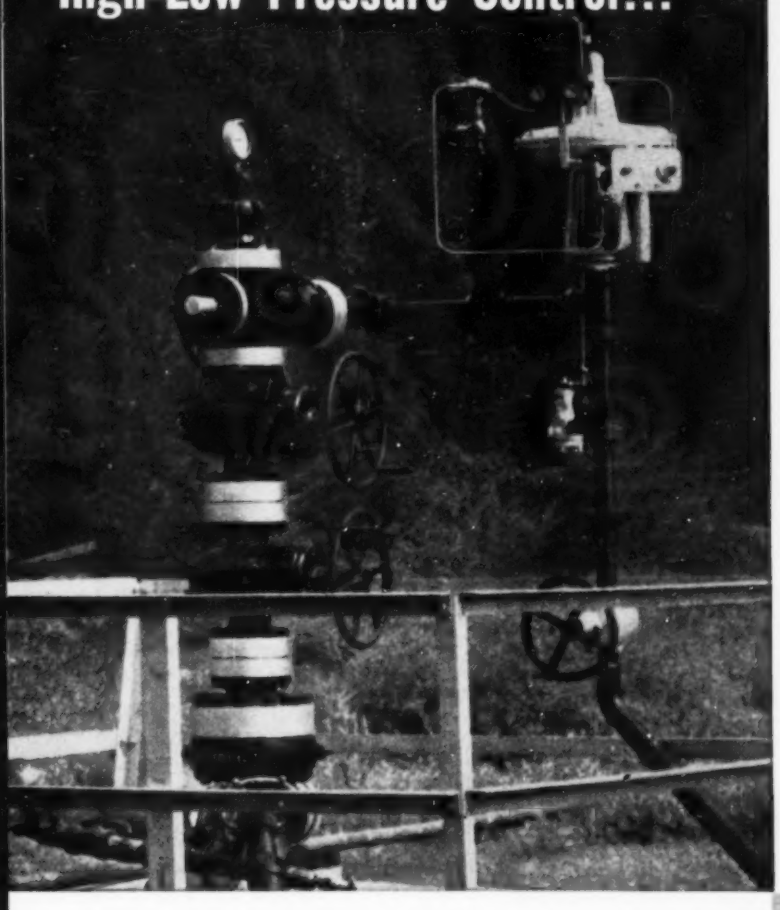

BS&B Type 1401 High-Low Pressure Pilot on high pressure well in a Louisiana field.

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Personals

joined Mathieson as a process development engineer in 1951. **Joseph E. Baker** has been named director of operations of the Niagara plant. He has been with the company since 1934.

• • •

Robert S. Tulin, one-time Pacific Coast natural gas and gasoline division manager of Shell Oil Co. who has been on special company assignment the last year and a half, has retired after more than 32 years service.

Mr. Tulin

Mr. Tulin started with Shell in 1920 as an electric plant operator at Oilfields, became plant superintendent of the Santa Fe Springs gasoline plant in 1924, general superintendent for all of Shell's Pacific Coast gasoline plants in 1925 and manager of natural gas and gasoline division in 1931.

A past president of the California Natural Gasoline Assn., Mr. Tulin has been a member of that group 27 years.

• • •

Frank M. Allen has been named district superintendent in charge of the new Cities Service Oil Co. gasoline plant near Blackwell, Okla. Mr. Allen first joined the company in 1929 and since 1947 has been district superintendent of Oklahoma City operations. He will continue to supervise activity of the firm's gasoline and chemical plants in that area.

Guy W. Duren is supervisor of operations at the new plant which began production the first of this month. **F. P. Dyer** is maintenance supervisor. Mr. Duren has been with the company since 1948, and Mr. Dyer since 1926.

• • •

James G. Hough, superintendent of Continental Oil Co.'s petrochemical plant at Baltimore, has been promoted to the newly-created position of petrochemical manufacturing superintendent. With headquarters at Baltimore, Mr. Hough will be responsible for the company's petrochemical manufacturing activities in that city and Chicago.

Walter Miller succeeds Hough as Baltimore plant superintendent.

Dr. George E. Hinds, assistant to the manager of Conoco's petrochemical department, has been appointed market development representative

(To obtain more data on advertised products see page 768)

for the firm's petrochemical department.

Mr. Hough is a 1943 chemical engineering graduate of Michigan State. Mr. Miller is a mechanical engineering graduate of Maryland Institute. Dr. Hinds is a 1936 organic chemistry graduate of Purdue.

* * *

Louis C. Stork has joined the staff of the American Petroleum Institute as supervisor of the new abstracting section now being organized.

Mr. Stork

Mr. Stork received his BA from Yale in 1935, and his MA from Columbia in 1940. He joined The Texas Co. in 1942, and since 1946 has been supervisor of the Beacon, N. Y., laboratories of that firm. A member of the American Chemical Society, he is the author of two papers, "Abstracting Research Reports" and "Simplifying Bibliographic Procedures", both presented before the Society.

* * *

J. Edward Taylor has been named director of the newly-established automotive engineering division of Gulf Research & Development Co. He received his BS degree from the University of Pittsburgh in 1934, and joined Gulf Research that same year as an automotive engineer.

Charles A. Butler and **R. L. Kirkpatrick** will be assistants to the director. Mr. Butler got his engineering degree from the University of Maryland in 1927, joining Gulf Research in 1933; Mr. Kirkpatrick, a mechanical engineering graduate of the University of Pittsburgh, came with the company in 1934.

Activities of the automotive engineering division are devoted primarily to fundamental engine studies. The division is split into four sections: aviation, automotive fuels, automotive lubrication and automotive service.

* * *

A. C. Hershey, Wood River, Ill., **H. M. Steininger,** Sugar Creek, Mo., **E. K. Brown,** Casper, Wyo., and **J. C. Baillie,** Neodesha, Kan., have been named laboratory superintendents in their respective areas by the Standard Oil Co. (Indiana). No change in duties and responsibilities has been made from their former positions as chief chemists.

At the Wood River laboratory, four other shifts have been made. **W. W. Johler,** group leader, becomes

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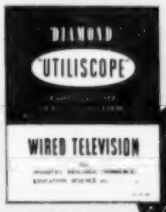

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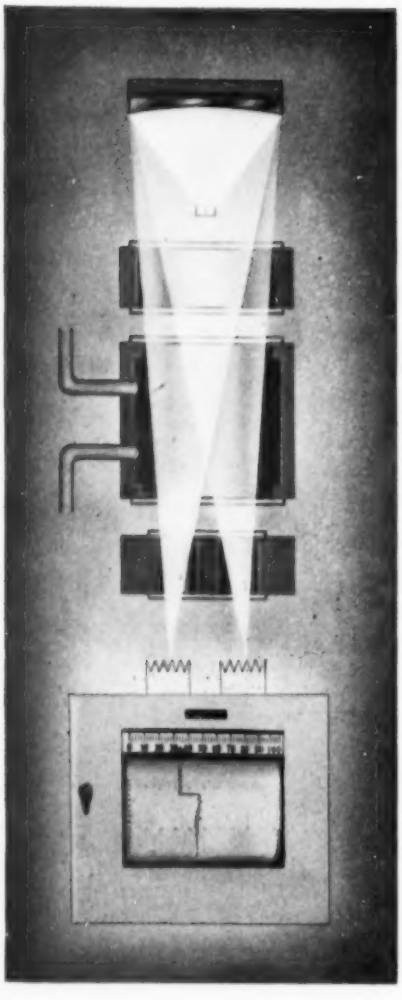

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Personals

chief chemist in charge of oil inspection and analytical work. **C. R. Ditto,** analytical laboratory foreman, becomes group leader in charge of analytical work and knock testing. **H. L. Hilleary,** group leader, becomes assistant laboratory superintendent in charge of general technical service, scheduling and refinery economics. **J. W. Morris,** chemical engineer, becomes group leader in charge of light oils technical work.

* * *

Donald M. Nace of Socony-Vacuum Oil Co.'s research and development department, Paulsboro, N. J., has been awarded that firm's 1953 Incentive Fellowship.

Born in Hanover, Penna., Mr. Nace graduated from Lehigh University in 1947 with a BChE degree, and two years later received his MS in physical chemistry from the same school. Since that time he has been working at the Socony laboratories in Paulsboro. He plans to use the fellowship to work toward his PhD in physical chemistry.

Socony established the annual fellowships in 1947 to "improve the academic training of laboratory employes who have shown more than usual ability . . ." Salaries of award winners continue while they seek higher academic degrees for a period not to exceed three years.

* * *

Adrian C. West received the 1953 Walter D. Hodson Junior Award of the American Society of Lubricating Engineers at the Society's annual banquet in Boston last month. Mr. West was given the award in recognition of his paper "Friction and Boundary Lubrication" presented before the ASLE northern California section last year. A graduate of San Jose State College, Mr. West has been with Cal Research, a Standard Oil Co. of Calif. subsidiary, since 1946.

* * *

Chris F. Neely has been named staff engineer of the Liquefied Petroleum Gas Association. He will devote his time to the group's technical and safety activities, making his headquarters in Chicago.

A native of Cincinnati, Neely received his BS degree from Massachusetts Institute of Technology in 1948, and his MS from Tulsa University in refinery engineering.

* * *

Morton Sterling, vice president in charge of manufacturing, Sunset Oil Co., Los Angeles, has been named to the newly-created position of executive vice-president.

(*To obtain more data on advertised products see page* 768)

REFINERY PROCESS NEWS

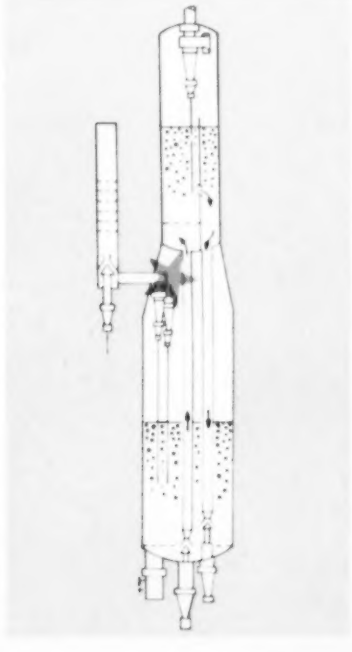
PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY — MAY 1953

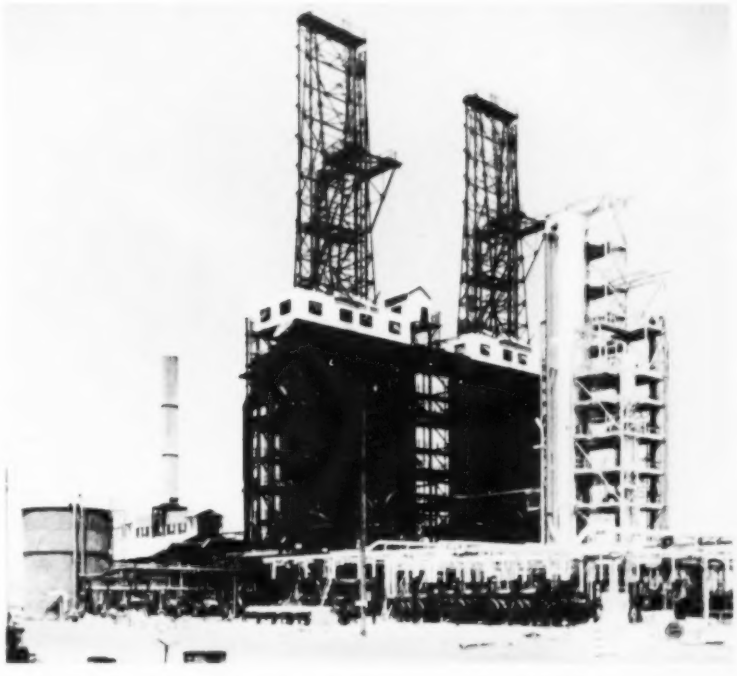
Simple Change in Orthoflow Unit Radically Reduces Catalyst Loss!

A comparatively simple modification in the regenerator of the first domestic Orthoflow unit has radically reduced amount of catalyst lost with stack gases. Tests over a period of better than two months prove that the catalyst loss factor of the Orthoflow is now as low as that of the best side-by-side Fluid units. Gasoline yields from this unit also continue to match the best yield records of the conventional crackers.

While designed for an 8300 BPD throughput, this first unit has been operating on synthetic MS catalyst at 9300 BPD — with conversion maintained at 67% because of the weak fuel oil market. In operation, the debutanized gasoline averages 93 octane clear, despite the fact that a certain percentage of naphtha is present in the feed.

The modification made in equipment to effect the catalyst saving does not alter the basic design of Orthoflow units nor affect their low investment advantages. Currently nine other Orthoflows are either operating, under construction or being engineered.





Changing Product Economics Increases Interest in Delayed Coking Process

In view of the deteriorating market for residual fuel oil in certain areas and no indications that it will greatly improve in the future, refiners in many parts of the country are reaching the decision that a coking step is the most logical solution to this economic problem.

Not only has the moderate winter piled up supplies of residuals in several sections of the country but basic industry uses have continued to slack off. Exports are down and no one can reliably predict that import restrictions will not be lifted.

While this situation does not obviate the use of other feed preparation steps (for example, Kellogg was named just recently to design and erect a 55,000-BPD vacuum flasher on the West Coast and is currently building a 28,000 BPD solvent deasphalter on the Gulf Coast) it does place Delayed Coking in a key position.

Petroleum coke is marketable today in virtually every part of the country — in contrast with the situation a few years ago when it had value only as refinery fuel in a number of locations. Further its price ranges as high as $10 a ton or more, depending on quality. In addition to customary uses, there is an increasing demand for petroleum coke in the manufacture of the carbon electrodes used in aluminum production. Roughly seven-tenths of a pound of petroleum coke is required to produce one pound of primary aluminum.

All-in-all, it appears that the U. S. and Canada will consume well over a million tons of petroleum coke this year. By 1955, this same potential market may rise by nearly 50%.

The following brief economic evaluation of two major feed prep steps highlights their economic relationship under current market conditions. The study is based on

(continued on following page)

CONTINUED FROM PRECEDING PAGE

Delayed Coking . . . cont.

a typical refining sequence including recycle Fluid cracking, thermal reforming of naphtha, cat poly and alkylation. Feed was established as 40,000 BPD of 38.6° API paraffinic crude, topped to 32.5% bottoms, plus 4000 BPD of 26 lb. casinghead.

YIELDS, VOLUME % ON CRUDE

	Vacuum Dist.	Delayed Coking
Premium Gasoline (93 CFR R	14.2	14.0
Regular Gasoline (86 CFR R	54.1	56.1
Total Gasoline	67.3	70.1
Kerosene	12.0	12.0
Furnace Oil	11.1	10.7
Fuel Oil	10.1	3.0
Gas (fuel oil equivalent)	8.3	11.0
Coke (recoverable)	—	5.4

ASSUMED PRICE STRUCTURE

	Gulf Coast Unit Price	East Coast Unit Price
Premium Gasoline (93 CFR R, per Gal.	$0.1225	$0.1385
Regular Gasoline (86 CFR R, per Gal.	0.1125	0.1285
Kerosene, per Gal.	0.0925	0.1075
Furnace Oil, per Gal.	0.08625	0.0975
Fuel Oil, per Bbl.	1.63	2.10
Gas (fuel oil equivalent), per Bbl.	0.66	2.10
Coke (recoverable), per Ton	10.00	10.00

ECONOMIC COMPARISONS

	Delayed Coking
Incremental Credits over Vacuum Distillation, per year	
East Coast	$1,207,000
Gulf Coast	1,155,000
Incremental Investments in Processing Equipment	
East or Gulf Coast	1,100,000

New Low Cost Desulfurization Demonstrated

Recently completed at Llandarcy by Anglo-Iranian Oil Company, Ltd. this 3,500 BPD Autofining unit is typical of a type of plant now being licensed on a worldwide basis by Kellogg. In view of the increasing quantities of sour crudes being used by domestic refiners, a desulfurization process like this one could be of great importance to processors who are having difficulty meeting sulfur specs for diesel and heating oils.

Autofining is fixed-bed catalytic desulfurization designed to treat all types of distillate stocks except those which include a high percentage of unsaturates. It is a low temperature, moderate pressure, high space-velocity process which provides an excellent low cost means of producing sweet distillates from sour crudes with extremely low liquid volume losses and with high sulfur reduction.

For a unit of 3,500 BPD capacity, the direct operating cost per barrel of feed ranges from about 11 cents for gas oil to 10 cents for kerosene. This can be compared with conventional sulfuric acid treating costs of 48 and 16 cents respectively. Investment cost for an Autofining unit is somewhat greater than that for acid treating. Nevertheless, incremental payout time for the new process over acid treating is approximately one year for gas oil operation and slightly longer for kerosene operation, depending on sulfur reduction.

For further information, technical data, etc., on any refining process, write

ARGENTINIAN REFINERY . . . 75% COMPLETE

Work has reached the 75-per-cent-completion stage on a 28,300 BPD catalytic refinery in the Argentine. The new plant is being erected by Yaciementos Petrolíferos Fiscales at Eva Perón (formerly La Plata) and will be called the Presidente Perón Refinery.

Shown are two of the major units, vacuum distillation to the left, and straight-run gasoline fractionation to the right. Other units, being constructed by YPF under the supervision of Kellogg Pan American Corporation, include a Fluid catalytic cracker, an alkylation unit and one of the world's largest Delayed Cokers. In addition, there will be two crude units, one of 21,000 BPD capacity and the other charging 7300 PBD. Thermal cracking and catalytic polymerization are also part of the sequence.

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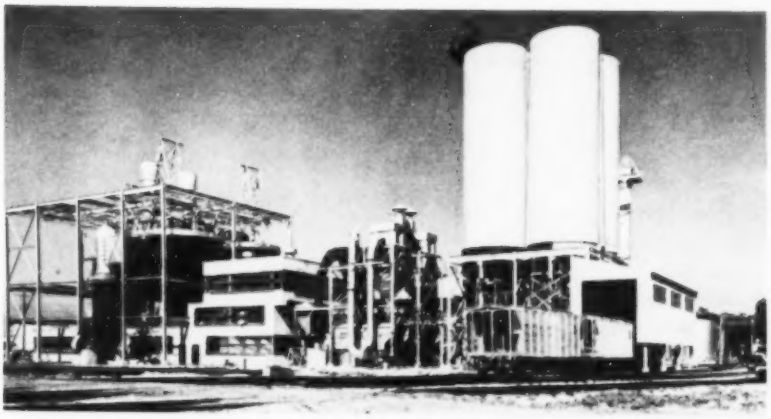

New Catalyst Plant in Southwest

DEDICATED APRIL 28, this new $7 million catalyst plant at Lake Charles, La., of Davison Chemical Corp. will have an annual capacity of 45 million lbs. Shown here, l to r: furnaces and spray driers, secondary filter and water treating area, flash driers, and finished product silos with hopper cars. Almost completely automatic in operation, plant will run continuously with nine men at five instrument panels in complete control of the process.

New Kellogg Division

M. W. Kellogg Co., New York, has set up a special division for process design of petrochemical and chemical plants. Charles C. King, with 14 years in Kellogg's process department, heads the new division. He will be in charge of work on processes for production of olefins, higher alcohols, acetone, ammonia, urea, aromatics, phenol and other cyclic alcohols, and phthalic anhydride.

L. J. Kelly has been put in charge of the newly-formed refinery process division. He will be responsible for process design of all refinery units, excepting those in the lubricating oil and petrochemical fields. Both Divisions will function under Paul F. Swanson, manager of Kellogg's process engineering department.

New Wheelco Branch Addresses

New addresses have been announced for the following branch sales offices of Wheelco Instruments Division, Barber-Colman Co,. Rockford, Ill. With the men in charge, they are: Baltimore area—William Karslo, 338 E. 25th St., Baltimore 18; Boston area—E. W. Heffernan, 435 Newtonville Ave., Newtonville 60, Mass.; Chicago area—H. F. Dahlke, 2651 N. Clark St., Chicago 14; Houston area—G. H. Hatfield, 1951 Richmond Ave., Houston 6.

New York area—Herb Proske, 66 Hudson St., Hoboken, N. J.; Philadelphia area—J. W. Hancock, 1433 W. Erie Ave., Philadelphia 40; Rockford area—Vic Lathers, 1300 Rock St., Rockford, Ill.; Rock Island area—H. C. Reimers, 3714 14th Ave., Rock Island, Ill.; Springfield area — Ken Coates, 1011 Ridgely Bldg., Springfield, Ill.; Montreal area — George Knowler, 6693 Park Ave., Montreal 15, P. Q., Canada.

Svihel to New Kuljian Dept.

Kuljian Corp., Philadelphia, has established a new electronics division and placed Bernard T. Svihel in charge of it. A graduate of the University of Minnesota, Mr. Svihel was a member of the electrical engineering staff at the Massachusetts Institute of Technology for six years. For four years he was with the Franklin Institute in charge of electronic computation and simulation.

Mr. Svihel

The new division is an outgrowth of Kuljian's work in electronic controls for power plant installations. It will continue applications of electronics not only to this field, but to all types of industrial regulation and control systems.

Swartwout Jr. Is VP

Kenyon Swartwout, son of Denton K. Swartwout, president of Swartwout Co., Cleveland, is now executive vice president of that company. A Case Institute graduate in mechanical engineering, the younger Swartwout has been chief engineer of the power plant division for the past five years.

In other sales department changes, Ernest H. Bellard becomes sales manager, M. M. Ward becomes sales manager, power plant division, and Robert J. Jones becomes sales manager, process division.

Buys Porter Valve Business

Ohio Injector Co., Wadsworth, has acquired the lubricated plug valve business of H. K. Porter Co., Tulsa. Production equipment is being moved to Wadsworth this month, and no lag is anticipated in flow of products to distributors. Ohio Injector's new line of valves will be marketed through its own network of distributorships.

Cooper Wins Sohio Contract

Cooper-Bessemer Corp., Mount Vernon, has been awarded a contract to build two 1000 hp, 6-cylinder, motor-driven gas compressors for the new 12,000 b/d catalytic reformer at Standard Oil Co.'s (Ohio) Lima refinery. Procon, Inc., Chicago, is general contractor for the job. The reformer is a UOP-designed Platformer. Both compressors are to be delivered this fall.

Rockwell to Open Valve Plant

Rockwell Mfg. Co. will open a new valve and meter plant in Sulphur Springs, Texas, later this year. Now under construction, the plant will be devoted largely to production of "Nordstrom" valves, particularly 4 in. and smaller "Hypresecal" valves in varying pressure ranges. Output will go primarily to users in Texas, Oklahoma, Louisiana and Mississippi.

Nalco Builds Catalyst Plant

National Aluminate Corp,, Chicago, is puting up a new catalyst plant in Southgate, Calif. Construction begins this month, with full scale production expected by January 1, 1954. This installation, sixth in the Nalco organization, will supply synthetic fluid cracking catalyst demands of west coast area refiners.

Beckman Branch Moves to N.J.

Beckman Instruments Co. is transferring its New York offices to a new plant in Mountainside, N. J. this month, which triples the size of the firm's present east coast operation. Functioning as northeast sales and service headquarters for the parent California company, the new building will also provide branch manufacturing facilities for the Beckman Helipot division.

Personnel Changes

Colorado Fuel and Iron Corp. — W. W. Leonard to assistant manager

Faster, Simpler Gasoline Analyses for Tetraethyllead!

... Another New Time-Saving Beckman Flame Photometer Application!

Again the Beckman Flame Photometer has brought new speed and simplicity to chemical procedures—this time a quick, accurate method of testing unknown gasoline samples for tetraethyllead content.

- *As perfected by Pan American Refining Corporation, this new method cuts analysis time to only 5 minutes per determination!*
- *It eliminates need for unloaded gasoline stock as a base reference—a reference not always available in normal refinery operations!*
- *Coupled with its unusual speed and simplicity, this new technique has shown an accuracy of 0.01 ml./gal. in a series of 15 TEL determinations!*

This is one more in a constantly-growing list of time- and money-saving applications for Beckman Flame Photometers. Why not investigate today the important savings to be made in *your* operations? Details on the above application, as well as data on many other uses for the Beckman Flame Photometer, are available from your nearest Beckman dealer. Or give us the field of analysis in which you are interested and ask for Data File 36-155.

BECKMAN INSTRUMENTS control modern industries

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5310

Beckman Instruments include: pH Meters and Electrodes — Spectrophotometers — Radioactivity Meters — Special Instruments

Suppliers

of tubular sales, from district manager of tubular sales for Continental Supply Co. in Shreveport, La.

Minneapolis - Honeywell Regulator Co.—O. B. Wilson to the newly created post of industrial ins'ruments sales manager of the Industrial Division.

B-I-F Industries—Herman E. Trotter joins firm as Buffalo sales representative.

Black, Sivalls & Bryson, Inc.—W. M. McGinnis to Houston district sales manager from salesman in that same area.

Calumet & Hecla, Inc.—Horace Y. Barsett to vice president of operations from vice president and general manager of the company's Wolverine Tube Division. C. Chester Jung to vice president of finance, Donald W. Blend to general manager of the Wolverine Tube Division and Francis J. Gibbons to controller.

Chase Brass & Copper Corp.—Payne C. Barzler to district manager of the newly-created sales district in Houston from Southern Texas sales representative.

General Controls Co.—H. A. McIntosh joins firm as head of newly-formed department to study customer requirements in design and development of automatic controls.

The Lubrizol Corp.—Russell J. Ferree to a company directorship in addition to his present duties as treasurer.

Naugatuck Chemical Div., U. S. Rubber Co.—Earle S. Ebers to director of research and development and D. Lorin Schoene to assistant director of same department.

Refinery Supply Co.—R. W. Vanderveld joins firm as manager of warehouse and branch office in Houston.

Rockwell Mfg. Co.—J. H. Walters to Houston district sales manager from gas sales supervisor.

Schade Valve Mfg. Co.—Herman G. Ebert joins company as vice president in charge of sales promotion.

Branches, Distributors

Insul-Mastic Corp. of America has appointed S. W. Kooperman, Inc., Philadelphia, as a licensee to handle

WOLVERINE TUBING

Plain

Wolverine tube possesses the greatest measure of *long-life-quality* that expert skill and years of experience can ever put into any tube.

And to make sure you will ultimately realize from your installation all the potential that Wolverine tube can supply, we suggest you ask our Customer Engineering Service to give you further assistance in the selection of tube of the proper alloys that will best meet your particular operating conditions.

Some of the most popular alloys: copper, cupro-nickel, brass, red brass, 70-30 brass, Muntz metal, aluminum and electric welded steel.

WOLVERINE TRUFIN*

Finned

Trufin is a unique finned tube distinguished by its integral fin construction. With its fins extruded right from the tube wall, the tube, you see, is one

piece of metal, and consequently cannot be affected by vibrations or sudden temperature changes.

Nominal sizes range from 3/8" to 3/4" root diameter. Furnished with thick-walled plain ends to permit best assembly.

Alloys available: copper, cupro-nickel, red brass, admiralty, aluminum, aluminum-brass, SAE 1010 steel, and stainless steel.

*REG. U.S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

WOLVERINE TUBE DIVISION

of CALUMET & HECLA, INC.

Manufacturers of Tubing Exclusively

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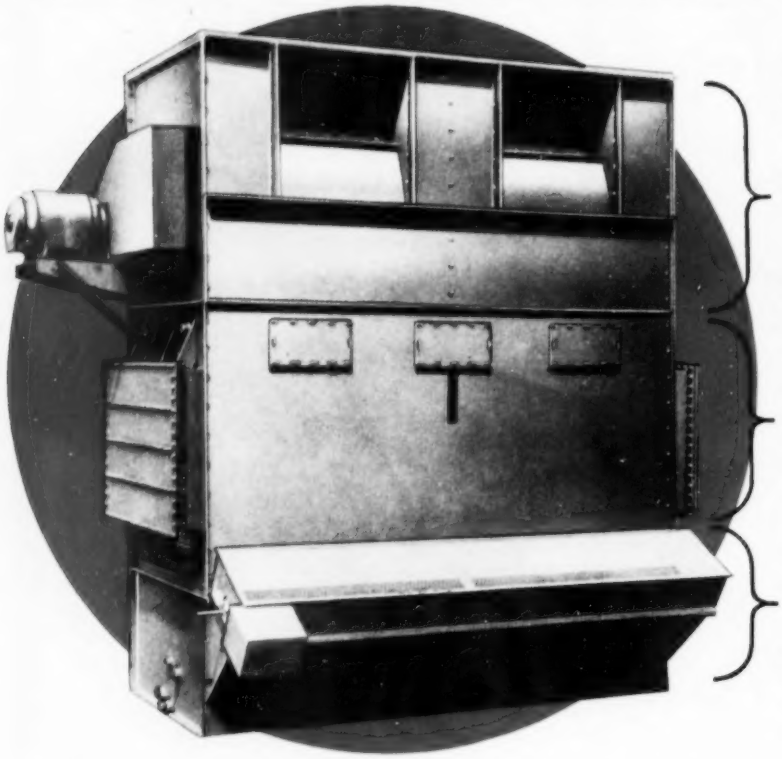
Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

When you attend the Inform-A-Show in Los Angeles May 24-27, be sure to visit our Booth 304

Solve Big Cooling Problems with YOUNG EVAPORATIVE COOLERS



BLOWER SECTION

Built as a complete unit, this section consists of dynamically balanced multi-blade centrifugal blower, outlet scrolls for the blower housing, standard NEMA splash-proof motor, variable V-belt drive and air discharge duct. The blower fan is corrosion-resisting, double inlet design, dynamically balanced for long life, quiet operation.

COIL SECTION

Cooling coil section consists of straight, round, seamless tubes—copper, stainless steel or red brass—each rolled into header plates with baffles for multi-pass flow. Gasketed tank cover plates are used on coils for water and oil cooling. Tubes for cooling gases are rolled into steel tank headers with plugs opposite each tube for easy cleaning. Assembly also includes spray header, spray nozzles, moisture eliminators and inspection windows.

SUMP SECTION

The bottom, or sump section, consists of a water-tight, galvanized and rust-resistant reservoir for makeup and spray water, self-regulating float valve, and thermostatically controlled automatic shutters for the air inlet, air outlet, or both. The float valve automatically provides the volume of makeup water required to compensate for water losses due to evaporation and wastage.

Full length access door in sump tank for ease of service, and cleaning sump.

COOL— Jacket Water . . . Steam . . . Lube Oils . . . Natural Gas

For maximum heat transfer efficiency, select Young Evaporative Coolers to solve your big cooling problems. Versatile in design and completely self-contained, YEC units cool the liquid or gas in the coil by evaporation when water is sprayed over the coil assembly. Units are used primarily for cooling engine jacket water and lubricating oil (gas, gasoline, Diesel engines), steam, compressed air, natural gas or other fluids, and also for condensing steam, hydrocarbons, etc.

Designed and engineered to give long, efficient performance, Young Evaporative Coolers are built in six basic models, either with single or two coil assemblies. Normal operating pressures of 100 psig

CONDENSE— Hydrocarbons . . . Steam . . . Other Fluids

are used for water and oil cooling. However, for steam and natural gas cooling and condensing, pressures up to 2000 psig can be handled. Unit capacities range from 876,000 to 8,712,000 Btu's per hour.

Coil assemblies for water, oil and gas service consist of straight, round, seamless copper, stainless steel or red brass tubes, each rolled into thick header plates at each tank with multipass baffles. Oil cooling units use chain-type agitator strips inside the tubes to increase heat transfer. Straight Admiralty tubes in the Gas Cooler coil assembly are rolled into steel tanks with a plug opposite the end of each tube for easy cleaning. For special cooling jobs, call on a Young Representative, or write direct.

YOUNG

Young Quality

GET THIS NEW CATALOG!

Illustrated Catalog No. 1952 gives specifications, dimensions, capacities and features of YEC units.

YOUNG . . . AN "OLD" NAME IN HEAT TRANSFER ENGINEERING

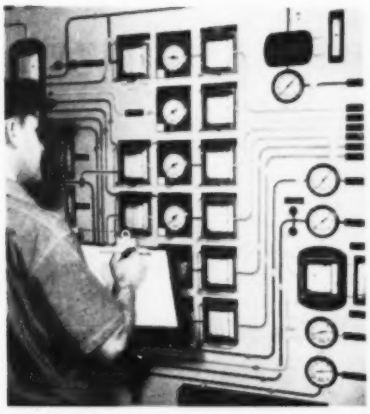
YOUNG RADIATOR COMPANY

Dept. 263-E • Racine, Wisconsin • Factories at Racine, Wisconsin and Mattoon, Illinois

OIL FIELD DISTRIBUTORS: TULSA—J. R. Meek Co., 1341 S. Boston St., Rm. 109 • LOS ANGELES—Flournoy & Everett, Inc., 5043 Santa Fe Ave. • MUSKEGON—Harold J. Young, 206 Montgomery Blvd.

Other Representatives in Principal Cities

See our Exhibit at the International Petroleum Exposition, Tulsa, Okla. May 14-23. Booths 67-68 in Scientific and Technical Building.



AUTOMATIC PROCESS MONITORING in a lube oil process at Marcus Hook refinery of Sun Oil Co. uses new ultra high-frequency sound and electronic instrument, the "Ultra-Viscoson." The instrument, developed by Rich-Roth Laboratories of Hartford, Conn., was sold recently to Bendix Aviation Corp., representing Bendix's entry into the field of industrial process instrumentation. Ultra-Viscoson was described in PETROLEUM PROCESSING a year ago (May, 1952, p. 698). As used by Sun, it provides continuous automatic recording of the viscosities of six side-stream cuts on a vacuum still.

sales and application of Insul-Mastic protective coatings in that locality.

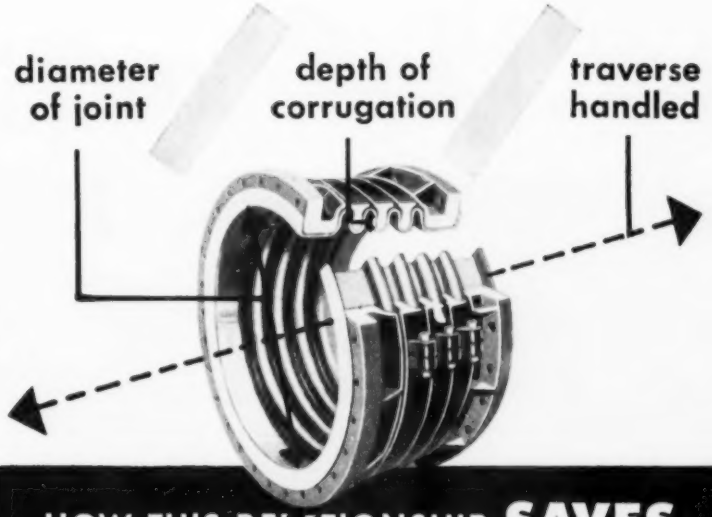
Remington Arms Co. has appointed the Nelson Stud Welding Division of Gregory Industries, Inc., Lorain, Ohio, as national distributor for its Remington stud driver and fastener studs.

Warren Steam Pump Co. manufacturers of centrifugal, reciprocating and rotary pumps has appointed Wilcox Engineering Co., 126 Wellington Place, Cincinnati 19, Ohio as its representative in that area.

Expansion, Transition

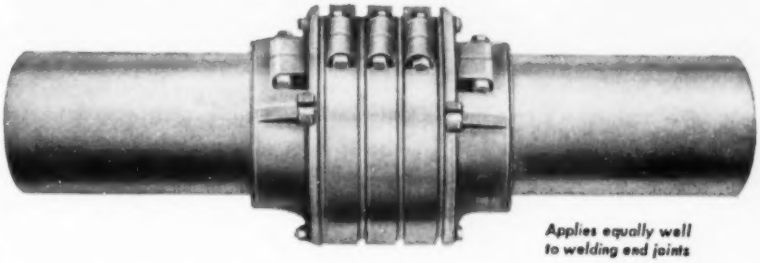
Engineering Research Associates, electronic engineering division of Remington Rand, Inc., has leased space in the Midway Terminal Warehouse Bldg., 2295 University Ave., St. Paul, Minn. Additional facilities will be used to accommodate expanded electronic computer and precision instrument development and production.

Sims Pump Valve Co. has moved its administrative, manufacturing and sales operations to: 1314 Park Ave., Hoboken, N. J. Telephone: Hoboken 4-0803.



HOW THIS RELATIONSHIP **SAVES** IN EXPANSION JOINT COSTS

For each range of BADGER Expansion Joint Diameters, there is a carefully calculated depth of corrugation and a definite limit of traverse to be absorbed by this corrugation. The traverse is gauged to the depth of corrugation.



Applies equally well to welding end joints

With four different corrugation depths, there is no need either to overstress tube metal when forming the corrugation or to "over-traverse" the expansion joint installation in order to be sure of having ample capacity. The former assures longer joint life; the latter saves you in initial cost. You don't have to risk "under-traversing" the job. The joint, being just right for the job, means maximum life.

The more you study the Badger Expansion Joint—both the Self-Equalizing Directed Flexing and the Non-Equalizing Types—the more you will see and appreciate the careful engineering that has gone into these joints. And the more you study the work an expansion joint is to do, the more you will appreciate why sound engineering is a 'must' in expansion joints. You get it in Badger Joints.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET • CAMBRIDGE • MASS.

(To obtain more data on advertised products see page 768)

BIG NEWS at the TULSA INTERNATIONAL PETROLEUM EXPOSITION

See the

Bendix Ultra-Viscoson

the instrument that

• measures • records • controls

VISCOSITY

• instantaneously • continuously • automatically

Simple
Flexible
Reliable

No moving parts

Hermetically sealed probe

Operates in temperatures from −109° to 650°F. and pressures of 1000 p.s.i. (special units available for higher pressures)

Measurements made in milliseconds

Remote operation

Probe can be permanently installed

Easily combined with remote recorder and automatic controls

Multi-probe systems available if desired

Now viscosity can be measured directly and continuously in industrial processes, by the Bendix Ultra-Viscoson. No longer is it necessary to measure viscosity by tedious sampling or through less satisfactory "secondary" characteristics, such as temperatures for lube oils, drilling muds, asphalt, tars, plastics, etc.

Combining the science of ultrasonics and electronics in a simple, reliable equipment, the Ultra-Viscoson provides viscosity measurements directly with speed and accuracy. Simply install the small rugged probe in pipeline, kettle, pressure vessel, fractionating tower or tank, and you get an instantaneous and continuous check of viscosity as the process progresses. An associated recorder-controller readily provides automatic control of viscosity for continuous processes. Over the past two years, several hundred Ultra-Viscosons have brought real savings in many different industrial applications. If you are interested in increased profits through instantaneous and continuous viscosity measurement and control, be sure to see the Bendix Ultra-Viscoson in operation at the Tulsa International Petroleum Exposition . . .

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For full particulars write to

BENDIX AVIATION CORPORATION

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Export Sales: Bendix International Division • 72 Fifth Ave., New York 11, N.Y.

ASTM-IP Petroleum Measurement Tables Released in Three Editions

ASTM-IP Petroleum Measurement Tables, prepared jointly by the American Society for Testing Materials and the British Institute of Petroleum; 7x10 in., xv + 525 pages, stiff cloth binding. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Prices: American Edition $8.75; British Edition $7.00; Metric Edition $7.70.

After years of cooperative work with the British Petroleum Institute, the American Society for Testing Materials has published its ASTM-IP Petroleum Measurement Tables in three editions, the "American', "British" and "Metric."

The tables have been designed for use by all those who process, purchase, sell or use petroleum or petroleum products. An important factor in their development was recogition that use of internationally accepted conversion factors is necessary to eliminate possible discrepancies in volume and/or weight as determined by shipper and receiver.

Thirty-nine tables include data for all conversions given in the six tables of National Bureau of Standards *Circular C* 410, covering additional useful ranges of temperature and gravity. Other tables are provided to facilitate weight and volume conversions where more than one system of measurement is involved.

Tables are provided over normal operating ranges for reduction of gravity and volume to standard temperature, for calculation of weight—volume relationship, and interconversion of a wide variety of commercially useful units.

ASTM has published all tables applicable to units of measurement in the U. S., while IP has published those applicable to units in the British Commonwealth. IP has also published a volume in metric units. Not all tables are in each edition. A detailed listing of contents can be obtained from ASTM.

Type is large and legible, and each table is accompanied by an example with explanatory information.

NOTE: The National Bureau of Standards has announced that its Circular 410, *National Standard Petroleum Oil Tables*, will be withdrawn from circulation July 1, unless cogent reasons for retaining the circular are presented by interested parties. The information given in Circular 410 has now been incorporated in the new *ASTM-IP Tables*.

Although the original data on which the tables in Circular 410 and the *IP* 1945 *Tables* were based have been recomputed, the common portions of the new and the old are numerically identical except for minor changes involved in smoothing and rounding operations, NBS states.

These differences are for the most part only one or two units in the last digit and consequently have little significance for most practical uses for the tables. However, because of possible confusion from using two tables with slight numerical differences and because of the wider temperature range and scope of the new tables, NBS proposes to withdraw Circular 410.

Persons interested in requesting retention of Circular 410 should write to the Director, NBS, before June 15, 1953, c/o U. S. Dept. of Commerce, Washington 25, D. C.

Authors Revise Data On Commercial Chemicals

Chemicals of Commerce, by Foster Dee Snell and Cornelia T. Snell; 5½ x 8¾-in., viii + 587 pages, appendixed, stiff cloth binding. $6.50. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y.

This second revised edition, of *Chemicals of Commerce* brings up-to-date information on practically every chemical sold commercially. Using pseudo-technical language throughout, the value of the book is enhanced because it is suited for those who are dealing with chemicals, but who have little or no technical background.

The authors relate the chemical reactions involved in manufacturing chemicals. They also provide much information on physical properties without getting into too technical a description. Chemical formulas and symbols are used in order to briefly define composition and structure.

One chapter is devoted to those chemicals which are derived from hydrocarbons which do not come from petroleum sources, and another chapter covers the petroleum hydrocarbons and their related products.

Foster Dee Snell and Cornelia T. Snell are the authors. Mr. Snell is president of Foster D. Snell, Inc., New York consulting chemists. His co-author is also associated with the firm.

Traces Saudi-Arabia Oil Advancement

Saudi Arabia, 2nd edition (1952), by K. S. Twitchell; 5½x8½ in., xxi + 231 pages, indexed, stiff cloth binding. Princeton University Press, Princeton, N. J. Price $5.00.

Newly revised as of mid-summer 1952, this readable account of modern Saudi Arabia's economic, social and political development has a wealth of background material for industrialists planning expansion in this locality. A new final chapter "Developments Since 1946" is particularly concerned with advancement in the Saudi Arabian oil industry and transportation services. Earlier sections deal with topography, climate, agricultural and commercial wealth and the country's political structure. Seventy-three photographs, 50 of them newly added, three maps, a glossary of Arabic place-names, textual notes and a subject index are included.

Engineering Handbook in Second Revised Edition

Handbook of Engineering Fundamentals, 2nd edition (1952), edited by Ovid W. Eshbach; 5½x8½ in., x + 1075 pages, indexed, stiff cloth binding. John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y. Price $10.00.

Prepared by a number of authorities in specialized engineering fields, this comprehensive second edition was published last year. It is split into 14 sections, covering mathematical and physical tables; mathematics; physical units and standards; mechanics of rigid bodies; mechanics of deformable bodies; mechanics of incompressible fluids; aerodynamics; engineering thermodynamics; electricity and magentism; radiation, light and acoustics; chemistry; metallic materials; non-metallic materials; and a comparatively brief chapter on engineering law. A 52 page subject index is included.

1952 ASTM Volume Describes New Tests

1952 *ASTM Standards on Petroleum Products and Lubricants*, prepared by ASTM Committee D-2 on Petroleum Products and Lubricants; 6x9 in., xxi + 810 pages, indexed, heavy paper or stiff cloth cover. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price $5.75 (paper cover); $6.40 (cloth cover).

ASTM's new "Standards" contains ten new methods as well as a careful revision of previously published material. New work includes tentative specifications and test procedures for: farm tractor fuels, analysis of calcium and barium petroleum sulfonates, sulfur in jet fuels, calibrating upright tanks, etc.

Widely used standards included in this edition are: motor and aviation fuels, petroleum solvents and naphthas, diesel fuels, distillate and burner fuels, kerosine, lubricating oils, turbine oils, lubricating greases, petrolatums and paraffin waxes. The work contains a total of 135 ASTM standards, of which 119 are test methods.

Cut wire fence re-coating costs!

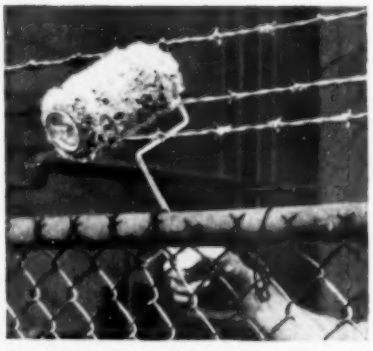
Users Report Savings of 30% to 40% With Rust-Oleum Extra-Long Nap Lamb's Wool Roller!

Special roller glides easily over wire sections. (Rusted sections have already been primed with Rust-Oleum 769 Damp-Proof Red Primer to Stop Rust.) Finish coat is Rust-Oleum 470 R.M. Aluminum.

A *new, exclusive, different-type* roller! Greater diameter, specially selected skins, extra-long Lamb's Wool – all combine to give you more coverage faster and easier in the new Rust-Oleum Roller-Coating System.

Close-up shows how Extra-Long Nap Wool reaches around to coat approximately 70% of other side of fence at same time. Rust-Oleum's *exclusive* penetrating qualities saturate cross wire sections for desired mil thickness.

Man follows with "dry" roller on opposite side of fence to catch and use surplus "tears" and quickly coat remaining 30% of wire sections.



Even barbed wire sections can be roller-coated in one easy pass. 99% of the material is used on the fence – *not* on the workers, *not* on the ground.

On long distances of fencing, a 5 man production "team" can achieve even greater savings. The first man wirebrushes the surface to remove dirt, dust, rust scale, etc. The second man applies Rust-Oleum liberally by roller, coating the wire sections and barbed wire. The third man follows on the opposite side of the fence with a "dry" roller to catch and use the surplus. The fourth and fifth men work on opposite sides of the fence, brushing the pipe framework and the barbed wire arms. See how this new Rust-Oleum system can save you money. Attach coupon to your letterhead, mail *today*.

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STOPS RUST!

RUST-OLEUM CORPORATION
2478 Oakton Street, Evanston, Illinois

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BOOTH NUMBER 129

INTERNATIONAL PETROLEUM EXPOSITION

PALMER

MERCURY ACTUATED
Temperature Indicating Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial seporable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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PALMER

THERMOMETERS, INC.
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Books

Treats Heat Transfer As Transport Process

Heat Transfer Phenomena, by Dr. R. C. L. Bosworth; 5½x9 in., xii + 211 pages, indexed, stiff cloth binding. Associated General Publications Pty. Ltd., Sydney, Australia; in U. S. by John Wiley & Sons Inc., 440 4th Ave., New York 16, N. Y. Price: $6.00.

This volume, a much expanded version of a paper presented at a technologic conference in Sydney, Australia in 1948, presents heat transfer phenomena as a particular example of the class of transport phenomena. Dr. Bosworth deals first with the properties of this class of phenomena, and then shows how these properties can be modified by the various features of the process, such as the number of individual units responsible for transport, and the speed and geometry of the paths traced by these units.

Primarily concerned with recent developments in heat transfer, the book discusses heat in gases, radiative transfer, conduction in solids and liquids, forced and natural convection, heat flow with simultaneous phase change and use of electrical and other model methods. Presentation attempts to make clear significance of and limitation on the value of analogies between heat flow, fluid friction, chemical diffusion and the electric current. It attributes some of the special features associated with heat flow to the ubiquity of the "carrier" for molecular energy or heat. Photographs and many graphs are included.

Government Publications

Second Annual Report of the National Science Foundation, Fiscal 1952; 5¾x9 in., vii + 77 pages, heavy paper cover. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30 cents.

Government Publications

Annual Report, 1952, *National Bureau of Standards*, (Miscellaneous Publication 207 — U. S. Department of Commerce); 5¾x9 in., iv + 89 pages, heavy paper cover. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30 cents.

National Motor-Gasoline Survey, Summer, 1952. (Investigations Report 4963) by O. C. Blade in cooperation with American Petroleum Institute; 24 pages. Publications Distribution Section, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

Catalog of Radioactive and Stable Isotopes, with prices and descriptive information; published for the Atomic Energy Commission. Carbide & Carbon Chemicals Co., Oak Ridge National Laboratory, Radioisotopes Sales Dept. P. Oak Ridge, Tenn. Price $1.00.

Analyses of Crude Oils from Some West Texas Fields, II, Additional Analyses by E. L. Garton and G. M. McKinney; U. S. Department of Interior, Bureau of Mines Report of Investigations 4959. Copies can be obtained free from Bureau of Mines Publication Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

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YARWAY the steam trap

designed with more production in mind

(*To obtain more data on advertised products see page* 768)

ASTM Symposium Talks Over Radioisotope Use At 56th Meet

ONE of the highlights of the coming American Society For Testing Materials 56th annual meeting in Atlantic City June 29-July 3, will be a symposium and exhibit on radioactivity in ASTM work.

The symposium, sponsored by Committee E-10 on radioactive isotopes, will include the following talks: "Properties and uses of Radioisotopes" by G. D. Calkins, Battelle Memorial Institute; "Applications of radioactive measurements to ASTM work" by O. M. Elliott, Sun Oil Co.; "Design of radioisotope laboratories" by G. G. Manov and O. M. Bizzell, U. S. Atomic Energy Commission; "Training personnel in radioisotope techniques" by Donald R. Smith, Oak Ridge Institute of Nuclear Studies; "Instrumentation" by E. H. Wakefield, Radiation Counter Laboratories; and "Management problems resulting from radioisotope utilization by industry" by W. L. Davidson, U. S. Atomic Energy Commission.

Second half of the symposium will feature a demonstration period and a movie by AEC on "Methodology".

The exhibit will be continuous throughout the day, showing instruments and equipment utilizing radioactive materials.

Feedback Control Course Set For June At M.I.T.

MASSACHUSETTS Institute of Technology will conduct, June 22-July 3, a special summer program presenting a formalized theory for the analysis and synthesis of feedback control systems.

The two week course will be given under direction of Professor Donald P. Campbell, associate professor of electrical engineering, assisted by others of the M.I.T. staff.

First week of the program will be devoted to a review of the theory of measurement and feedback control. The second week will deal with advanced subjects, such as contactors, pulse control mechanisms, data sampling, distributed parameter systems, pneumatic and thermal systems, random signals and loads, and non-linear systems.

Further information can be obtained from the director of the summer session, Professor Ernest H. Huntress, Room 3-107, M.I.T., Cambrige 39, Mass.

Discuss Statistical Control At ASQC's 7th Convention

SIX papers of general interest to refinery men will be presented at the American Society for Quality Control's 7th annual convention, to be held at Philadelphia's Convention Hall May 27-29.

"Statistical Control in Continuous Chemical Processing" by R. M. Hofstead and H. W. Isleib of Bristol Laboratories, Inc., and "Plant Scale Experiments in Chemical Production" by J. A. Mitchell, Tennessee Eastman Co., will be presented on Wednerday, May 27 in the afternoon.

"The Application of Statistical Methods in Research and Development" by a speaker to be announced, and "Some Applications of Statistics in a Refinery" by C. T. Shewell, Humble Oil & Refining Co., will be given on Thursday afternoon. "Analysis of Dimensions and Tolerances" by Professor E. Buckingham, M.I.T., and "Statistical Methods and the Engineer" by Dr. J. H. Davidson, General Electric Co., will be delivered on Friday morning.

Tour Vickers Plant At WPRA Kansas Meeting

A special feature for the technical side of the program for the regional Technical-Industrial Relations Meeting, Western Petroleum Refiners Assn. to be held in Wichita, Kans. May 28-29 will be an afternoon-long inspection tour of Vickers Petroleum Co. plant at nearby Potwin, Kans. Highlight of this trip will be the new TCC packaged cracking unit recently put on stream, and a paper on construction features and operating experience will be given before the tour May 29.

Although other technical papers will be announced, a special-interest paper on "Development of Residuum Coking" will be presented by J. H. Eppard, process engineer for Blaw-Knox Construction Co. as co-author with W. F. Simms and F. D. Parker.

Industrial relations will be the subject of the May 28 meeting, with the list of speakers including C. L. Stinnett, assistant personnel director, Lion Oil Co.; Jack Tharpe, industrial relations superintendent, Stanolind Oil & Gas Co., and W. E. Blazier, personnel director, Beech Aircraft Corp., Wichita.

Mr. Stinnett will discuss the operation and results of Lion's new employe orientation program. The system adopted by Beech Aircraft to improve employes' attitude and inspire the will to work will be described by Mr. Blazier. Mr. Tharpe's topic will be "Contract Negotiation Techniques."

Oil Man's Calendar

MAY

Materials Handling Exposition, Convention Hall, Philadelphia, Penna., May 18-22.

Scientific Apparatus Makers Association, annual meeting, all sections, The Greenbrier, White Sulphur Springs, W. Va., May 24-28.

Air Pollution Control Ass'n., annual meeting, Lord Baltimore Hotel, Baltimore, Md., May 25-28.

American Society for Quality Control, 7th annual convention, Convention Hall, Philadelphia, Penna., May 27-29.

Western Petroleum Refiners Association, regional meeting, Hotel Broadview, Wichita, Kans., May 28-29.

JUNE

Society of Automotive Engineers, summer meeting, The Ambassador and the Ritz-Carlton Hotels, Atlantic City, N. J., June 7-12.

Manufacturing Chemists Association, joint meeting with **Synthetic Organic Chemicals Mfgrg. Association,** Greenbrier Hotel, White Sulphur Springs, W. Va., June 11-13.

Liquid Petroleum Gas Association, mountain states district convention and trade show, Troutdale-in-the-Pines, Evergreen, Colo., June 14-16.

Exposition of Basic Materials for Industry, Grand Central Palace, New York City, June 15-19.

Massachusetts Institute of Technology, special summer program on feedback control systems, M.I.T., Cambridge, Mass., June 16-26.

Western Petroleum Refiners Association, regional meeting, Conrad Hilton Hotel, Chicago, Ill., June 18-19.

American Society of Electrical Engineers, convention, University of Florida, Gainesville, June 22-26.

American Standards Ass'n., Gaillard Seminar On Industrial Standardization, Engineering Societies Bldg., 29 West 39th St., New York, N. Y., June 22-26.

American Society for Testing Materials, annual meeting, Atlantic City, N. J., June 29-July 3.

AUGUST

Society of Automotive Engineers, International west coast meeting, Georgia Hotel, Vancouver, B. C., Canada, Aug. 17-19.

SEPTEMBER

American Institute of Chemical Engineers, regional meeting, Fairmont and Mark Hopkins Hotels, San Francisco, Calif., Sept. 13-16.

Instrument Society of America, 8th national conference and exhibit, Hotels Sherman and Morrison, Chicago, Ill., Sept. 21-25.

Western Petroleum Refiners Ass'n., regional meeting, Hotel Henning, Casper, Wyo., Sept. 24-25.

OCTOBER

Packaging Institute, 15th annual Forum, Hotel Statler, New York City, Oct. 12-14.

Scientific Apparatus Makers Ass'n., mid-year meeting of recorder-controller section, Seaview Country Club, Absecon, N. J., Oct. 14-16.

Society of Industrial Packaging and Materials Handling Engineers, exposition, technical short course and competition, Mechanics Hall, Boston, Mass., Oct. 18-24.

Western Petroleum Refiners Ass'n., regional meeting, Garrett Hotel, El Dorado, Ark., Oct. 22-23.

Association of Consulting Chemists and Chemical Engineers, annual meeting (25th anniversary), Hotel Belmont-Plaza, New York City, Oct. 27.

NOVEMBER

Packaging Association of Canada, annual convention, Toronto, Nov. 1-7.

American Petroleum Institute, annual meeting, Chicago, Ill., Nov. 9-13.

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(To obtain more data on advertised products see page 768)

June 1 May Find U.S. Gasoline Stocks 25,000,000 Bbls. More Than Year Ago

IT WILL not be until early June that refiners can accurately compare their product demand-supply position, particularly on gasoline, with their 1952 operations at the start of the summer.

The strike of refinery workers last May cut production by at least one-quarter. Gasoline demand was met by abnormally heavy withdrawals from refiners' stocks. Larger stocks this year at the end of April, with normal withdrawals in May, could leave the total volume May 31 at close to 150,000,000 bbls., over 25,000,000 bbls. larger than on May 31, 1952.

Crude runs to stills in May, '52 declined 25% from April, to 4,905,000 b/d av. Loss in production in May from April was about 18,000,000 bbls. of gasoline, 3,900,000 bbls. of kerosine, around 9,000,000 bbls. of distillate and 7,266,000 bbls. of heavy fuel oils. Starting in June, more crude was charged to enable refiners to make up for the draft on stocks. By August, total runs were over 7,000,000 b/d avg. and they have since remained close to this level.

Crude runs April, 1953 on domestic crude were nearly 4% larger than in April '52. Runs of imported crude were 22% larger. For three months, total runs were 4.3% larger than the first quarter of '52.

The Bureau of Mines forecasts crude runs in May at 6,740,000 b/d. The Independent Petroleum Assn. of America calls attention to a current total crude supply in excess of requirements for summer market demand, and forecasts runs to stills of 6,722,000 bbls. for the second quarter. This is 3.3% less than actual runs for the first quarter.

Motor Fuel — Refiners' gasoline stocks reached their peak buildup this year on March 21—163,324,000 bbls. This was 4,500,000 bbls. more than the 1952 peak of 158,816,000 bbls. reached March 29. By April 25 stocks had been reduced 5,334,000 bbls., to 157,990,000 bbls., compared with withdrawals of 3,450,000 bbls. to April 26, '52. On April 25, gasoline stocks were 2,623,000 bbls. larger than on April 26 a year ago.

By the end of May, '52, with the strike ended, gasoline stocks at refineries were 123,656,000 bbls., a reduction of 31,700,000 bbls. from stocks of 155,367,000 bbls. on April 26, 1952. In the normal years of 1951 and 1950, gasoline stocks were reduced about 7,000,000 bbls. during the month of May. A reduction of about 10,000,000 bbls. this year from April 25 to May 31 would leave gasoline stocks in refiners' hands at around 148,000,000 bbls., or 25,000,000 bbls. larger than on May 31, 1952.

From June 1 on, in 1952, refiners had no difficulty in meeting demands through the motoring season and ended with stocks at about 120,000,000 bbls. on October 31. Their stocks then were about 10,000,000 bbls. higher than at the end of the withdrawal seasons in both 1951 and 1950. So, unless gasoline production this summer is considerably curtailed, refiners could be burdened with top-heavy stocks in later months. Table 1 shows the distribution of gasoline stocks by refining districts on April 18 this year and April 19, '52.

Heating oils — Indicated refinery production of kerosine and distillates in April was 5.6% larger than April '52, while for the first quarter it was 1.9% larger than the previous year. Indicated April demand was 12% greater than April a year ago, but for the first quarter demand was 1.8% more.

Heating oil stocks April 25 were 79,935,000 bbls. compared with 69,820,000 bbls. April 26, '52. The increase was mostly in distillate stocks. These stocks increased only about 1,400,000 bbls. from April 26, '52 through May and at the end of May were 71,262,000 bbls., some 8,500,000 bbls. less than stocks this year on April 25. Normal increases this May will greatly increase the current difference in volumes of these stocks.

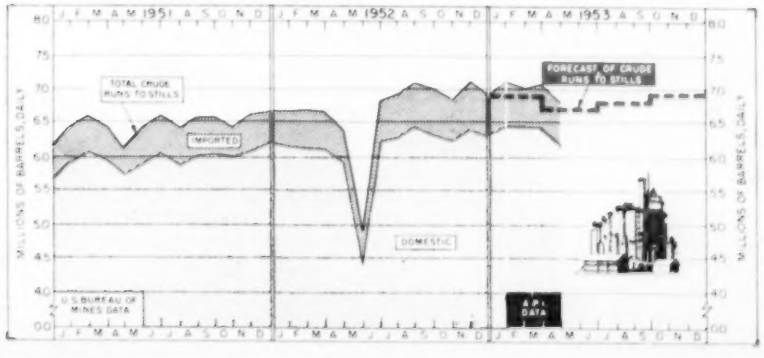
Residual fuels — Total volume of refinery output and imports thus far this year is close to that in 1952. Demand has been about 2% larger. Stocks continued to decline in April, the total being nearly the same as at the end of April '52. Stocks east of California are the lowest in two years.

Table 1—Gasoline Stocks by Refining Districts April 18, 1953 and April 19, 1952

(1000 Bbls., API Data)

District	Apr. 18, '53	Apr. 19, '52	Change	% Change
East Coast	34,914	32,115	+2,799	8.7
Gulf Coast	28,385	32,321	−3,936	12.1
Total Coastal	63,299	64,436	−1,137	1.8
Appalachian	5,725	5,973	−248	4.2
Ind.-Ill.-Ky.	35,333	36,949	−1,616	4.3
Okla.-Kans.-Mo.	18,166	18,114	+52	0.3
Other Inland	16,684	15,784	+900	5.7
Total East of Calif.	139,207	141,256	−2,049	1.5
California	18,735	16,136	+2,599	16.1
Total U. S.	157,942	157,392	+550	0.4

Fig. 1—Domestic Crude Runs Drop in April



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Apr. '53 API*	6,156	620	6,776
Apr. '52 BM	5,927	508	6,435
Change	+229	+112	+341
% Change	3.9	22.0	5.3

*Through Apr. 25

Total (1000 bbls.)

(Bureau of Mines Data)

3 Mos. '53*	575,970	55,200	631,170
3 Mos. '52	561,599	43,579	605,178
Change	+14,371	+11,621	+25,992
% Change	2.6	26.6	4.3

*March estimated from API data

BM Forecast of Crude Runs to Stills, 1953

(Dec. 26, 1952; 1000 b/d avg. by quarters)

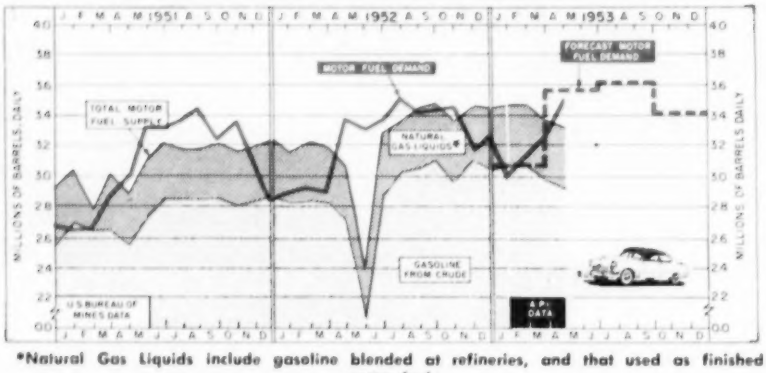
1st Q., 6,920 2nd Q., 6,750 3d Q., 6,810 4th Q., 6,972

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
Apr. '53 API*	43.5	5.6	20.6	18.4
Mar. '53 API	42.3	5.4	21.0	18.3
Feb. '53 BM	44.1	5.8	21.6	18.3
Apr. '52 BM	42.5	5.7	20.4	19.5

*Through Apr. 25

Fig. 2—Sharp Climb in Gasoline Demand


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MOTOR FUEL DEMAND
FORECAST MOTOR FUEL DEMAND
TOTAL MOTOR FUEL SUPPLY
NATURAL GAS LIQUIDS*
GASOLINE FROM CRUDE
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, DAILY

*Natural Gas Liquids include gasoline blended at refineries, and that used as finished motor fuel.

Fig. 3—Gasoline Stocks Start Seasonal Decline

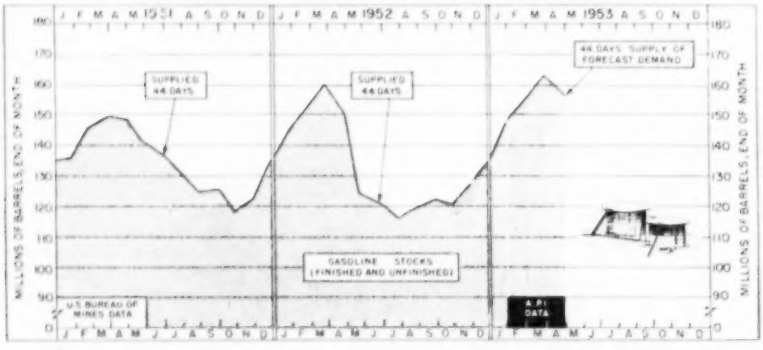

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
SUPPLIED 44 DAYS
SUPPLIED 44 DAYS
44 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED AND UNFINISHED)
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, END OF MONTH

Fig. 4—Moderate Drop in Heating Oil Output

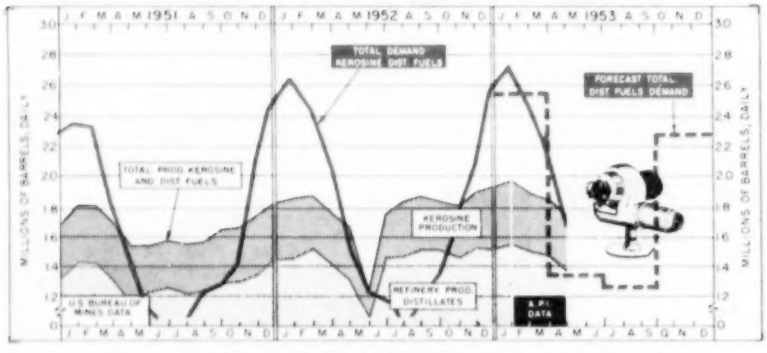
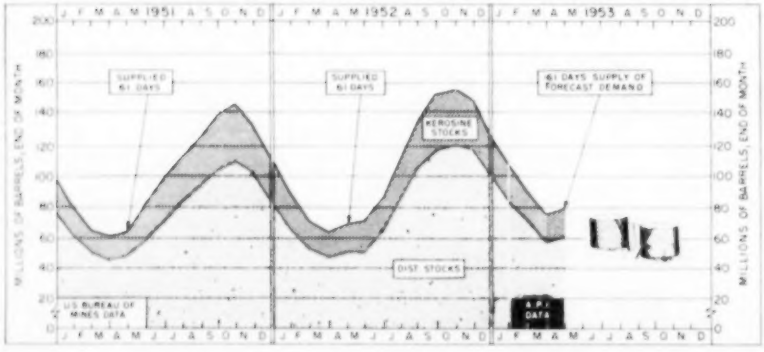

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
TOTAL DEMAND KEROSINE DIST. FUELS
FORECAST TOTAL DIST FUELS DEMAND
TOTAL PROD KEROSINE AND DIST FUELS
KEROSINE PRODUCTION
REFINERY PROD. DISTILLATES
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, DAILY

Fig. 5—Heating Oil Stocks Turn Upward


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
SUPPLIED 61 DAYS
SUPPLIED 61 DAYS
61 DAYS SUPPLY OF FORECAST DEMAND
KEROSINE STOCKS
DIST STOCKS
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, END OF MONTH

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Apr. '53 API*	2,948	390	3,338
Apr. '52 BM	2,727	358	3,085
Change	+221	+32	+253
% Change	8.1	9.0	8.2

*Through Apr. 25

Total (1000 bbls.)
(Bureau of Mines Data)

3 Mos. '53*	273,766	35,037	308,803
3 Mos. '52	256,594	34,184	290,778
Change	+17,172	+853	+18,025
% Change	6.7	2.5	6.2

*Mar. estimated from API data

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Apr. '53 API*	3,523
Apr. '52 BM	3,392
Change	+131
% Change	3.9

*Through Apr. 25

Total (1000 bbls.)
(Bureau of Mines Data)

3 Mos. '53	281,979
3 Mos. '52	264,164
Change	+17,815
% Change	6.7

*March estimated from API data

BM Forecast of Motor Fuel Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 3,055 2nd Q., 3,560 3d Q., 3,609 4th Q., 3,402

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Apr. '53 API*	157,990
Mar. '53 API	162,608
Feb. '53 BM	157,873
Apr. '52 BM	151,890

*Apr. 25

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kero-sine	Dist. Fuels	TOTAL
Apr. '53 API*	379	1,393	1,772
Apr. '52 BM	366	1,312	1,678
Change	+13	+81	+94
% Change	3.6	6.2	5.6

*Through Apr. 25

Total (1000 bbls.)
(Bureau of Mines Data)

3 Mos. '53*	36,331	135,229	171,760
3 Mos. '52	35,746	132,857	168,603
Change	+785	+2,372	+3,157
% Change	2.2	1.8	1.9

*March estimated from API data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kero-sine	Dist. Fuels	TOTAL
Apr. '53 API*	345	1,362	1,707
Apr. '52 BM	295	1,230	1,525
Change	+50	+132	+182
% Change	16.9	10.7	11.9

*Through Apr. 25

Total (1000 bbls.)
(Bureau of Mines Data)

3 Mos. '53*	45,572	176,451	222,023
3 Mos. '52	46,017	172,213	218,230
Change	−445	+4,238	+3,793
% Change	1.0	2.5	1.8

*March estimated from API data

BM Forecast of Heating Oils Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 2,566 2nd Q., 1,352 3d Q., 1,250 4th Q., 2,272

Heating Oil Stocks

(1000 bbls. end of month)

	Kero-sine	Dist. Fuels	TOTAL
Apr. '53 API*	19,433	60,502	79,935
Mar. '53 API	18,564	59,742	78,306
Feb. '53 BM	20,468	67,167	87,635
Apr. '52 BM	18,955	51,634	70,589

*Apr. 25

Fig. 6—Residual Imports Lower in April

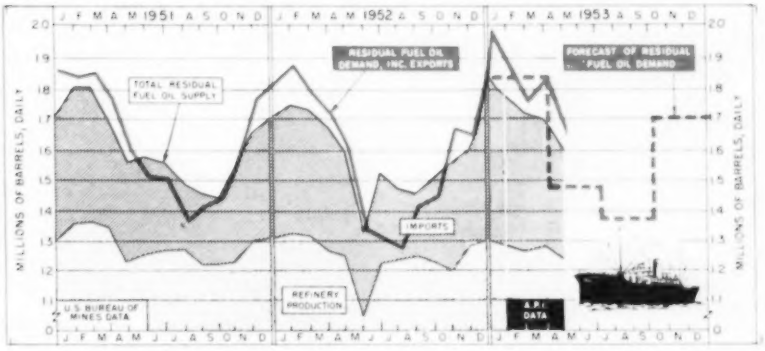
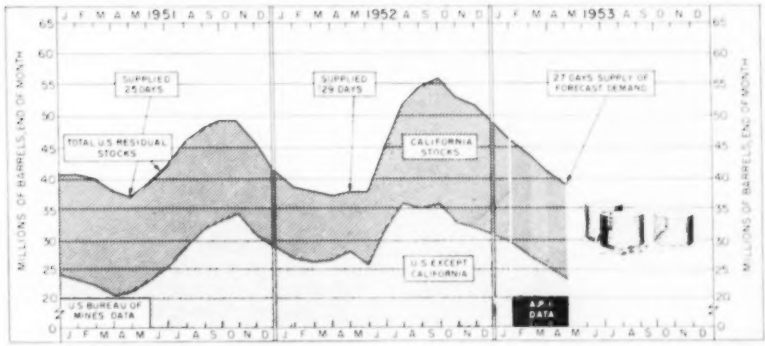

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
TOTAL RESIDUAL FUEL OIL SUPPLY
RESIDUAL FUEL OIL DEMAND, INC. EXPORTS
FORECAST OF RESIDUAL FUEL OIL DEMAND
IMPORTS
REFINERY PRODUCTION
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Fig. 7—Eastern 'Resid' Stocks Near 2-Year Low


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 25 DAYS
SUPPLIED 29 DAYS
27 DAYS SUPPLY OF FORECAST DEMAND
TOTAL U.S. RESIDUAL STOCKS
CALIFORNIA STOCKS
U.S. EXCEPT CALIFORNIA
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Apr. '53 API*	1,248	353	1,601
Apr. '52 BM	1,253	349	1,602
Change	—5	+4	—1
% Change	0.4	0.9	

*Through Apr. 25

Total (1000 bbls.)
(Bureau of Mines Data)

3 Mos. '53*	116,060	41,404	157,464
3 Mos. '52	119,317	37,548	156,865
Change	—3,257	+3,856	+599
% Change	2.7	10.2	0.4

*March estimated from API data

Residual Fuels Demand

Daily Average (1000 bbls.)

Apr. '53 API*	1,663
Apr. '52 BM	1,599
Change	+64
% Change	4.0

*Through Apr. 25

Total Demand (1000 bbls.)

3 Mos. '53*	166,672
3 Mos. '52	163,528
Change	+3,144
% Change	1.9

*March estimated from API data

BM Forecast Residual Fuels Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 1,844 2nd Q., 1,494 3d Q., 1,370 4th Q., 1,707

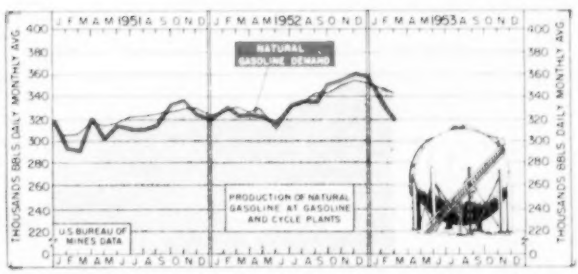
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	TOTAL U.S.
Apr. '53 API*	24,723	39,034
Mar. '53 API	24,705	40,572
Feb. '53 BM	27,519	44,178
Apr. '52 BM	28,433	38,561

*Apr. 25

Fig. 8—Supply and Demand of Natural Gas Liquids


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
THOUSANDS BBLS DAILY MONTHLY AVG
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA

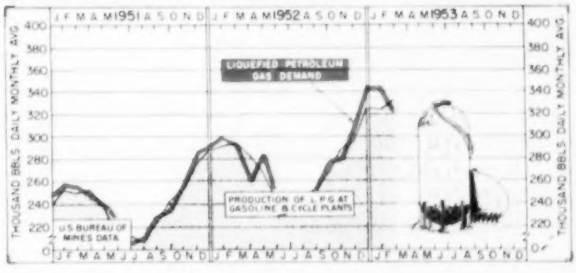
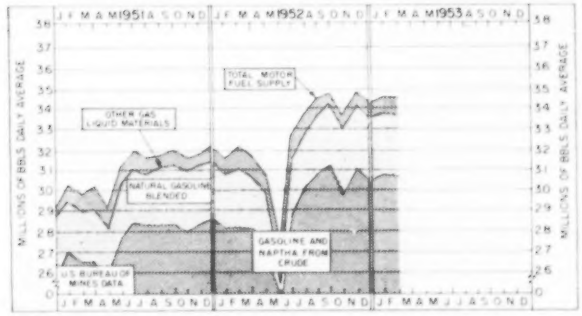

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
THOUSAND BBLS DAILY MONTHLY AVG
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF L.P.G. AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA

Fig. 9—Makeup of U.S. Motor Fuel Supply


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BBLS DAILY AVERAGE
TOTAL MOTOR FUEL SUPPLY
OTHER GAS LIQUID MATERIALS
NATURAL GASOLINE BLENDED
GASOLINE AND NAPTHA FROM CRUDE
U.S. BUREAU OF MINES DATA

(Figures in table in 1000 bbls./day average)

	Gasoline & Naphtha from Crude	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
Feb. '53	3,078	299	80	3,457
Jan. '53	3,084	300	81	3,465
Dec. '52	3,055	285	73	3,433
Feb. '52	2,829	280	102	3,211

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Supply* (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL	Demand** (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL
Feb. '53*	342	320	662	535	321	856
Feb. '52	332	296	628	523	287	810
Change	+10	+24	+34	+12	+34	+46
% Change	3.0	8.1	5.4	3.7	11.8	7.5

	Total Supply (1000 bbls.)			Total Demand (1000 bbls.)		
2 Mos. '53*	20,349	19,004	39,353	19,780	19,540	39,320
2 Mos. '52	19,782	17,650	37,432	19,681	17,480	37,161
Change	+567	+1,354	+1,921	+99	+2,060	+2,159
% Change	2.8	7.7	5.1	0.5	11.8	5.8

Stocks, End of Month (1000 bbls.)

	By type of product (At gasoline plants and terminals only) LPG	Natural Gasoline	Condensate	Finished Gasoline†	By Location Gasoline Plants	Refineries	Total
Feb. '53	1,655	2,340	309	1,453	5,257	1,991	7,248
Jan. '53	1,692	2,134	302	1,451	5,580	1,995	7,575
Dec. '52	2,191	2,011	315	1,292	5,724	2,083	7,807
Nov. '52	2,744	2,153	294	1,287	6,458	2,126	8,584

*Supply includes receipts from refineries as well as current production from natural gasoline and cycling plants. Receipts from refineries in February included 137,000 bbls. of natural gasoline.

**Demand does not include liquefied refinery gases produced for fuel and chemical purposes, which totaled 2,728,000 bbls. in February.

†Includes naphtha and other products.

ADVERTISERS' INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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(A-2) AIR PRODUCTS, INC. 723
(A-3) ALLIED CHEMICAL & DYE CORP., GENERAL CHEMICAL DIV. ..... Inside Back Cover
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(A-9) ARMOUR & CO. & SUBSIDIARIES 649
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(L-3) YARNALL-WARING CO. 762
(L-4) YOUNG RADIATOR CO. 756
(L-5) ZALLEA BROTHERS 667

WHAT'S NEW...

Redesigned Pour Test Cabinet Refrigerates down to —90°F.

. . . for greater accuracy and speed in such tests as ASTM D-97, AAF Specifications 3608, and API 506, it is claimed. Two cabinets cover the full range of cloud and pour tests. The three-compartment cabinet operates at 30° F., 0° F., and —30° F., while the two-compartment unit functions at —60° F., and —90° F. Individual thermostats are preset, automatically holding temperatures within 2° F. Operating temperature is reached rapidly, the coldest compartment attaining —90° F. in about 2½ hrs. "Rubatex" insulation and hermetically sealed joints hold down heat losses. Safety interlocking wiring prevents compressor damage when starting with a warm cabinet. Lids are light in weight, minimizing operator fatigue. Test compartments are recessed, but thermometers can be read easily without disturbing samples. Eight cloud and pour test jars can be placed in each compartment. Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle No. **1** *on Reply Card*

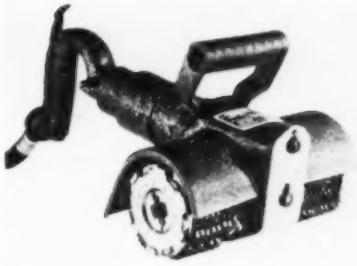
For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

Pneumatic Ejector Pumps Low Volume Fluids

. . . with presence of only one moving part, making it simple to install and simple in operation, it is said. "Pneu-Pump" can be operated from an existing compressed air supply, from a separate compressor, or with an auxiliary apparatus from a steam source. It's available with choice of cast iron, lead-lined, rubber-lined or stoneware bodies, and is claimed to be practically immune to higher temperatures, pumping liquids near the boiling point. The apparatus is built to handle "any fluid that will flow into it", and is adaptable to acids and other corrosives. Yeomans Bros. Co., 1999 N. Ruby St., Melrose Park, Ill.

Circle No. **2** *on Reply Card*



High Speed Chipping Tool Cleans Pipe Joints, Tanks

. . . economically and quickly, it is said, "Hand Revo-Tool" is designed to shear off hardened deposits of rust, old paint and other solidified residues. With 102 hardened steel cutters giving 3000 impacts per second, the unit cleans 100 sq. in. in a single 25 in. pass. Equipped with either a pneumatic or electric ¾ hp, 1200 rpm motor, the tool reportedly prepares metal surfaces for repainting at about 59% less cost than usual mechanical methods. One operator, it is claimed, can do the work of a four-to-eight-man hand scraping crew. Pneumatic model is 14½ in. long, weighs 16 lbs; the electric model is 16 in. long, weighs 24½ lbs. G. H. Tennant Co., 2566 N. Second St., Minneapolis 11, Minn.

Circle No. **3** *on Reply Card*

Porous Stainless Steel Filter Sheet Has High Strength

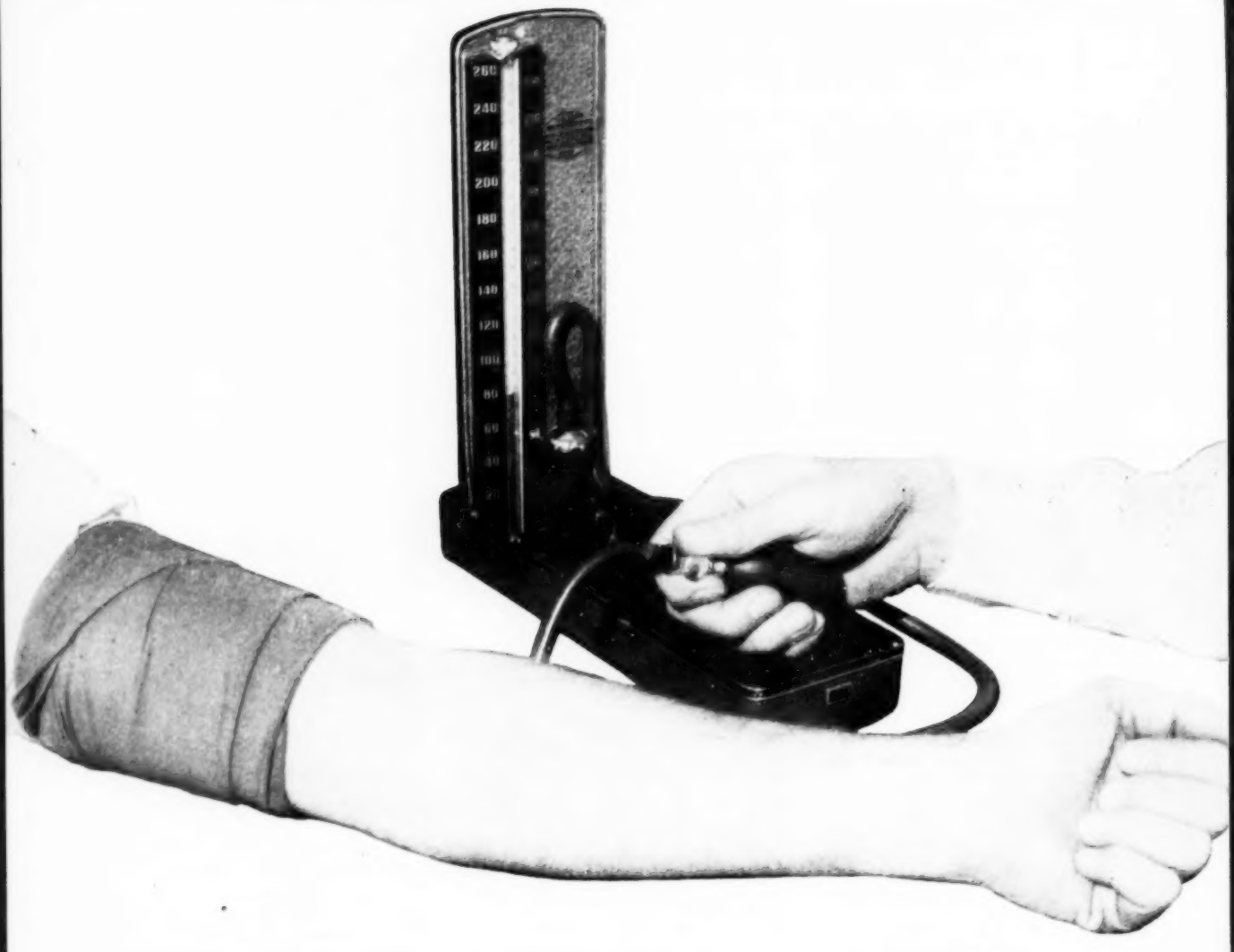
. . . and greater ductility than those previously available, according to the manufacturer. Tensile strength of this material, designated Grade X, is about 25,000 psi., and it is said the surface is so smooth it is difficult to distinguish it from a solid stainless steel sheet, except by microscopic examination. Sheet material is now available from stock in 0.040 thickness, with a mean pore opening of 10 microns. Other thicknesses ranging from 0.020 in. to ⅛ in. are either available from stock or can be supplied on short notice. Thickness tolerances are maintained to plus or minus 0.002 in. Manufacturer states this material can be fabricated into all forms in which porous stainless steel has hitherto been available. Micro Metallic Corp., 35 Sea Cliff Ave., Glen Cove, N. Y.

Circle No. **4** *on Reply Card*

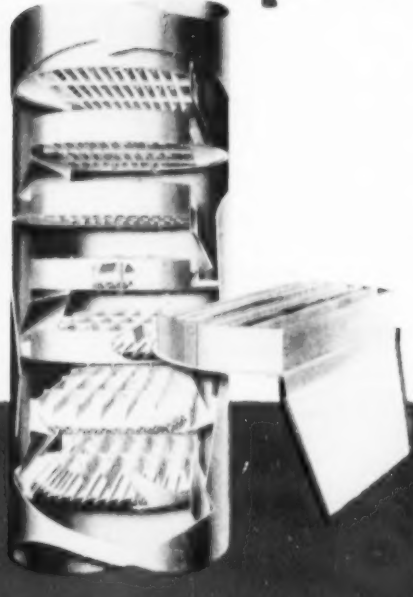
New Electronic Drive Control Will Adjust Motor Speeds

. . . in ranges from ¾ to 3 hp. "V-S, Jr." is available in ¾, 1, 1½, 2, and 3 hp. ratings. A constant torque variable horsepower drive, it operates from 270 to 3000 rpm and as low as 75 rpm for setting-up operations, light loads or intermittent duty. Its components are a drive motor, control unit and operator's control station. The latter apparatus is housed in a conventional (NEMA No. 1) enclosure, providing start-stop buttons, a jog-run selector switch and a stepless speed adjuster. The unit's three parts may be mounted close together, or widely separated, as equipment efficiency dictates. To meet requirements posed by special equipment applications or processing conditions, the drive motor is also available with all types of enclosures and mountings. In addition, certain optional equipment and accessories may be obtained, including three types of control stations: (1) foot-pedal operated for starting, stopping and speed control; (2) explosion proof, for use in hazardous atmospheres; and (3) reversing drum-switch, which provides forward and reverse functions with speed control. Reliance Electric & Engrg. Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio.

Circle No. **5** *on Reply Card*



Is pressure drop your problem ?



As simple as 2 plus 2—when you can recover 85% to 92% of the slot energy as mixing energy, you'll find your pressure drop problems are solved . . . and only Benturi Kaskade trays will give you this amount of recovery when and where you want it.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS · MANUFACTURERS · BUILDERS

321 WEST DOUGLAS — WICHITA 2, KANSAS

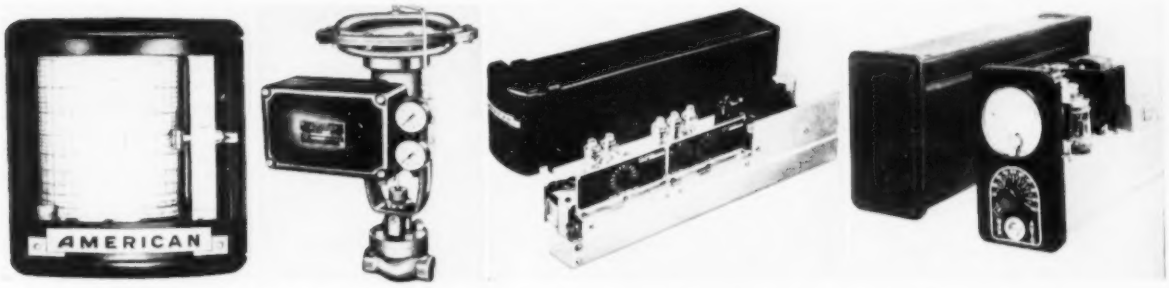
REPRESENTATIVES

Eastern and Export
30 Rockefeller Plaza
New York City

Pittsburgh, Pa., Repr.
D. D. Foster Co.
714 Frick Bldg.

Tulsa, Okla., Repr.
Myers-Bagwell Co.
Wright Bldg.

British Associates
Messrs A. F. Craig & Co., Ltd.
Paisley, Scotland

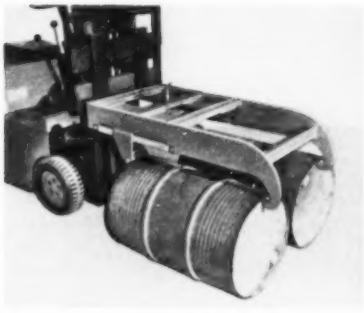


FOUR INSTRUMENTS, miniature recording controller, valve positioner, controller, and manual positioner station, are components of a . . .

New Electronic System for Process Control

Introduced by Manning, Maxwell & Moore, Inc. at the International Petroleum Exposition in Tulsa this month, the new "American" Electronic Process Control System utilizes electric and electronic transmission of measurement and operational signals. Designed for all processing industries, and particularly for petroleum or chemical, the system is claimed to have no transmission lag regardless of the distance from the process area to the control room panel. Component parts, illustrated above, include the miniature strip-chart recording controller, the electronic controller and the manual positioner station, all of which are mounted at the panel board; and an electro-pneumatic valve positioner which is located in the field. Stability of the system is said to be high so that narrower proportional bands can be used with sensitivity impossible to duplicate in any other type of actuation. Components are standardized to permit interchange at the panel regardless of the type of variable under control. Air is used in the system only at the positioner. Manning, Maxwell & Moore, Inc., Stratford, Conn.

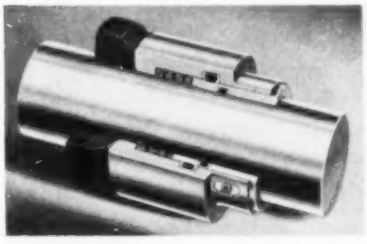
Circle No. **6** *on Reply Card*



Horizontal Handling Device Is Adjustable to Drum Size

. . . and interchangeable on the entire line of "Clark" fork trucks. The semi-automatic attachment is adjustable for horizontal lifting and tiering of drums from 26 to 38 in. in length, and almost any width within this range. Containers can be handled singly or in pairs, empty or full. The drum handler consists of two parallel arms with self-actuating levers projecting forward. Construction is heavy steel plate with steel channel sections providing rigidity and alignment. Over-all width of the unit is 26½ in., and it weighs 300 lbs. No tools for mounting or dismounting are necessary. The attachment is suspended from standard truck forks inserted into two channel-supports forming an integral part of the handler. Fork channels are located immediately beneath the unit's cross support arms. Installation or removal of the device is accomplished by inserting or removing forks. A single turn screw grips attachment to forks by a turn of the hand. Semi-automatic adjustment to various drum sizes is accomplished by rear finger-levers designed to slide along lower edges of the handler arms. Operating individually, they are spring-actuated for automatic retraction against drum rims when the load is lifted. They then lock against slipping. Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

Circle No. **7** *on Reply Card*



Ring Seals Are Made For Leakless Shaft Operation

. . . on centrifugal pumps handling chemicals, petroleum products and many other liquids. Type O, an unbalanced seal for pressures up to 200 psi, and Type OB, a balanced seal for pressures to and over 1,000 psi, are available. Both are supplied with single or multiple spring, in either pin-drive or sleeve-drive constructions. Balanced, sleeve-drive model shown in picture. O seals are for packing spaces 5/16 and larger, but in some cases can be made for ¼ in. Type OB seals are for spaces ⅜ in. and larger. O rings are obtainable in Teflon, buna-N, Neoprene or silicone. Metal parts contacting liquid can be furnished in any suitable metal. Garlock Packing Co., Palmyra, N. Y.

Circle No. **8** *on Reply Card*

High Speed Joint Cleaner Cleans Pipe Ends

. . . or threaded joints in six to eight seconds, and is built to speed reconditioning of old or reclaimed pipe. Air-operated, it will clean pipe ends 2 to 10 in. in diameter, with no changeover of equipment required to clean inside or outside. Unit consists of a drive motor and a head containing a spring-loaded brush guide and wire brush, which revolves around the pipe ends to remove all

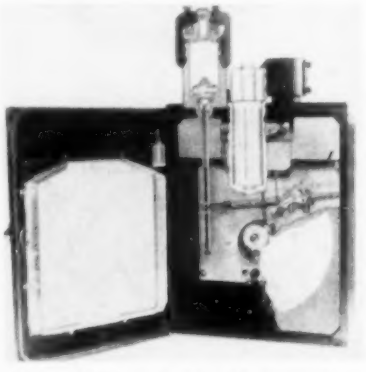
deposits. It also has provision for shooting solvent or cleaning fluid onto the pipe end, dissolving caked deposits. Power comes from the single stage, air-driven motor, slip-fit constructed. Brush head is a 2 in. replaceable wire brush. The cleaner head revolves around the pipe at 40 rpm. The entire unit weighs 16 lb. To clean inside pipe ends or threads, the brush is inserted into the pipe end to be cleaned. Airetool Mfg. Co., 399 S. Center St., Springfield, Ohio.

Circle No. **9** *on Reply Card*

Two-Way Coupling Shuts Off Air Pressure Automatically

. . . when hose joints are disconnected, eliminating need to open and close valves at the compressor tank. "Twinmatic" couplings have identical spring-seated valves in each end to prevent passage of air when disconnected. Pressurized air bears against the valve ends, sealing them positively. When couplings are connected, valves butt against each other and depress. This opens the seat and permits a free flow of air through the coupling. Underwater tests at 125 psi reportedly show no leakage in either half of the coupling, or in the assembly. Since both hose couplings are sealed, foreign particles are prevented from entering air tools, prolonging equipment life. Brass valves and seats are used, and coupling bodies are made of 356-T6 aluminum. Twinmatic Corp., 2246 S. Barrington Ave., Los Angeles 64, Calif.

Circle No. **10** *on Reply Card*



New 5000 psi. Hg Manometer Requires No Pressure Seals

. . . or stuffing boxes. Float position is transmitted by permanent magnetic coupling. Stainless steel float and range tubes permit its use with sour crude oils and other corrosive fluids. The manometer is essentially a conventional U-tube design, with float operating through a 2-in. linear travel in the low pressure range tube. Range tubes are available for 100, 200, and 400 in. water standard: tubes for higher differentials may be obtained also. Automatic temperature compensation is provided by means of an alloy rod within the float extension. This tube compensates for changes in mercury density and dimensional changes in the float extension from varying ambient temperature. The manometer is also offered with a recorder which can be used with McGaughey type continuous integrating mechanisms. Fischer & Porter Co., 10 Jacksonville Rd., Hatboro, Penna.

Circle No. **11** *on Reply Card*

Continuous Sulfur Monitor Now Offered For Sale

. . . replacing former "lease-only" stipulation, "Titrilog" monitors oxidizable sulfur concentrations as low as 0.1 ppm, or 0.005 grain/cu. ft., indicating concentration changes in less than 30 sec. Two models, the 26-102 for laboratory or plant installation, and the 26-103 portable, for plant or field use, are available. In addition to the "for sale" offer, units may still be purchased on a lease basis. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle No. **12** *on Reply Card*

DID YOU MISS THESE?

The following items, reviewed originally in the March issue, have aroused considerable interest. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, use the regular Reply Cards in this issue.

New Instrument Will Meter Weight Flow Rate Only

. . . in lb./min., for example. Yet it is totally insensitive to any other factors such as volume, temperature, pressure, viscosity, compressibility, or external accelerations. Basically, the mass rate of flow is measured by determining the moment necessary to give the mass a Coriolis acceleration. The construction is such as to produce a tangential velocity change in a given particle of the material whose flow rate is being determined. To obtain this velocity change, a force is acted upon the mass. The reaction to this force is exerted on the vane of a sensing element and in turn sensed by a torque tube. The measurement then consists of the amount of twist in the torque tube, or the phase shift between the sensing element and the rotating case. The new flowmeter will work on multiphase fluids such as mists, foams, slurries, and emulsions, as well as on homogeneous fluids. It is to be made available as rapidly as standards can be developed regarding sizes, flow rates, etc. First, however, the manufacturer will meet the most vital industrial and military needs. Control Engrg. Corp., Norwood 209, Mass.

Circle No. **13** *on Reply Card*

Liquid Density Is Continuously Indicated, Recorded, Controlled

. . . in the new "Princo Densitrol," with automatic temperature compensation. Any calibration can be furnished within limits of 0.2 to 0.005 density, or equivalent full scale range within the limits 0.5 to 3.5 density or equivalent. Accuracy for all ranges is ±3% of range, or 0.0002 density, whichever is greater. Sensitivity for all ranges of ±0.5% of range. Sensing element is a totally-submerged plummet fastened by a chain of known weight to a fixed reference point. For each density value within the range of the plummet-chain assembly, the plummet assumes a definite equilibrium position. Position changes are picked up magnetically. Construction materials permit use at operating temperatures up to 350°C. and pressures up to 600 psi. Precision Thermometer & Instrument Co. Dept. 7, 1434 Brandywine St., Philadelphia 30, Penna.

Circle No. **14** *on Reply Card*

Acetylene from Hydrocarbons

. . . by the Wulff Process, 24-page report with process description and simplified flow diagram, plus data on plant and manufacturing costs. The Lummus Co., Room 359, 385 Madison Ave., New York 17, N. Y.

Circle No. **15** *on Reply Card*

Temperature Measurement

. . . principles, basic types of control systems and their evaluation is covered in *The Design and Process Engineers' Guide to Industrial Temperature Measurement and Control*, discussing eight ways of responding to temperature; five ways of putting that response to work; and nine instrument types of the manufacturer. The Partlow Corp., New Hartford, N. Y.

Circle No. **16** *on Reply Card*

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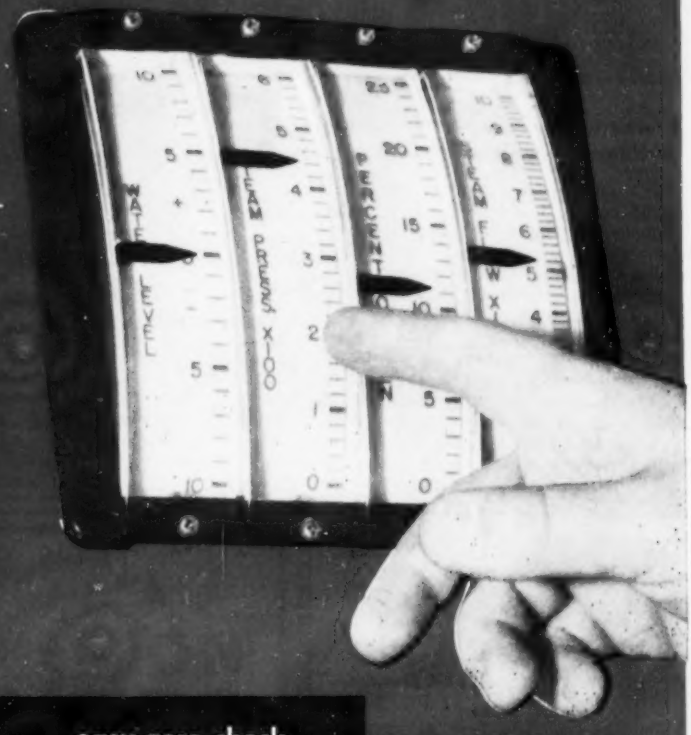

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The scale is only 5 inches long — easy to read — internally illuminated. Choice of pneumatic or electric transmission.

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Electronic Oxygen Recorders
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Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

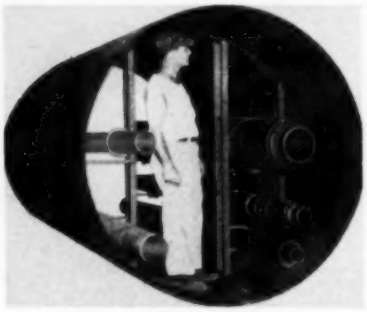
MICHIGAN CITY 23, INDIANA

(To obtain more data on advertised products see page 768)

Potentiometer Converts Analog Voltages into Decimal Digits

. . . with an accuracy of 0.1% (1000 counts full scale). The "Telereducer" Type 24A, operates upon demand, digitizes an input voltage and holds the digital representation for a controllable period of time for purposes of display, recording, or any desired readout form. The digital output can be recorded by means of punched card, an electric typewriter, magnetic tape, or punched tape. It may be used for digitizing the voltage output of such primary elements as thermocouples, strain gauges, telemeter receivers, and analog computers. Essentially a self-balancing digital potentiometer, it operates on 117 volts, 60 cycle, 75 watt power. The instrument measures 19 in. wide, 8 in. high, and 15¼ in. deep, weighs 45 lbs. Telecomputing Corp., 133 East Santa Anita Ave., Burbank, Calif.

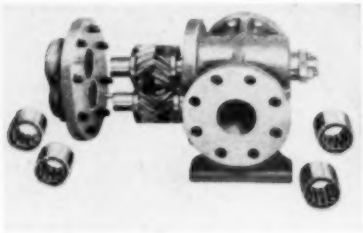
Circle No. **17** *on Reply Card*



Prefab Conduit Protects Underground Utilities

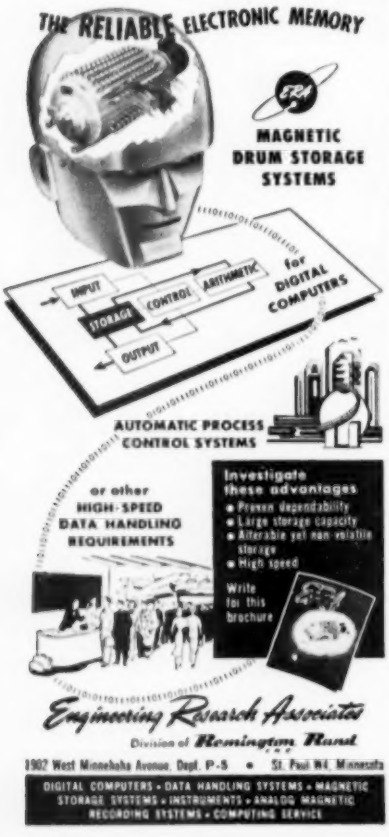
. . . providing easy access and inspection. "Utilidor" is prefabricated to job requirements, conduit being available in diameters 36 to 84 in. There is ample walk-through space in the larger tubes, which makes periodic inspection and maintenance possible. Utilidors are shipped in units 21 ft. long, with joint connections, and fittings such as tees and elbows made to fit exactly in conduit runs. Provision may also be made for electrical and communications cables, ceiling lights, etc. The housing is constructed of corrugated ingot iron conduit, hot-dip galvanized and protected with asphaltic or phenolic resin coatings. The Ric-wiL Co., Union Commerce Bldg., Cleveland 14, Ohio.

Circle No. **18** *on Reply Card*



Rotary Gear Pump Handles Fluids at 32 to 250,000 SSU

. . . with capacities from 1-500 gpm.; 300 psi. for continuous duty, 500 psi for intermittent service. Built primarily for positive displacement of lubricating liquids, this "Hydrex" pump has only two castings, body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and head, and two moving parts, the rotors. No inner races are needed in the bearings since shafts are hardened and ground at the bearings. Only one stuffing box is used, under suction pressure. Sier-Bath Gear & Pump Co., 9621 Hudson Blvd., North Bergen, N. J.

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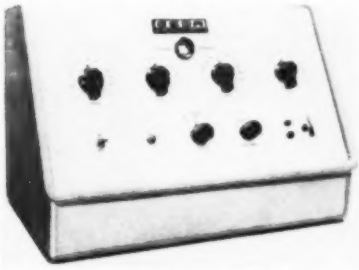


Impedance Bridge Eliminates Computer Sensitivity Controls

. . . providing for direct reading of capacitance and resistance. "M1 GEDA" can be used by personnel unfamiliar with electronic circuits. It is specially designed for use with GEDA linear and nonlinear analog computers, but can be used in all fields requiring precise measurements of resistance and capacitance. Resistance is measured over two scales, 0 to 1 megohm and 0 to 10 megohms. Maximum error is 0.15% or 100 ohm, whichever is greater, with probable error of less than 0.1%. Maximum capacitance measurement is one microfarad. Maximum error is 0.25% or 0.0001 microfarad, whichever is greater, with probable error less than than 0.2%. Unit operates on 110 volts AC, is 20 x 12 x 12 in. and weighs 20 lbs. Goodyear Aircraft Corp., Akron, Ohio.

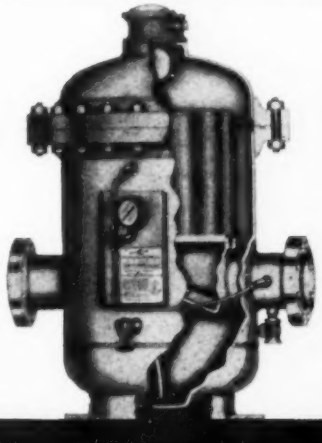
Circle No. **20** *on Reply Card*

Ultracentrifuge Force Hits Top Of 178,435 Times Gravity

. . . at a maximum speed of 39,460 rpm. Three separate 5.5-cc. samples of material can be handled in new Type SW 39 Spinco swinging-bucket rotor. Design is such that sedimentation conditions approach those in a conventional sectoral analytical cell, providing minimum reorientation of boundaries upon deceleration to rest. The rotor consists of a hub with three yokes, each supporting an individually-sealed bucket attached to the yoke by a removable pivot pin. Centrifugal thrust is carried by a heavy shoulder bearing against the rotor body when the bucket swings outward to 90°. A plastic stand facilitates the attachment and removal of

buckets outside the operating chamber of the ultracentrifuge. Each bucket holds a ½-in. diameter by 2-in. long plastic tube, and is sealed with a hand-tightened screw cap. Buckets, which can be adapted to fit any type of tube within the given dimensions and have a corrosion resistant finish, are designed to accommodate special quartz tubes where an absorption analysis is desired. Weight of the rotor, including loaded buckets, is 6 lbs. Specialized Instruments Corp., 623 O'Neill Ave., Belmont, Calif.

Circle No. **21** *on Reply Card*



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Responsible for the operations of a modern blending and packaging plant which is a part of a complete refinery of an independent oil company in the southwest. Must have thorough knowledge of drum reconditioning, drum and can filling, box car shipping, and lube oil blending operations. College degree preferred. Salary open subject to experience and qualifications.

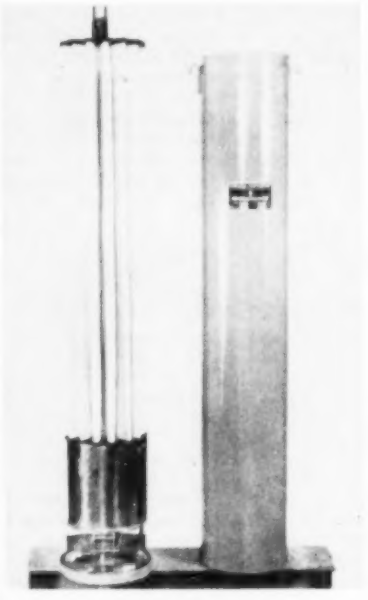
PETROLEUM PROCESSING
Box 43

ELECTRICAL AND INSTRUMENT ENGINEER

Responsible for the maintenance and installation of electrical equipment and instruments in a complete refinery of an independent oil company located in the southwest. Must have a degree in electrical engineering and at least 5 years experience in a refinery. Will assist Chief Engineer in developing specifications for electrical equipment and instruments. Will supervise the installation and maintenance of same. Salary open subject to experience and qualifications.

PETROLEUM PROCESSING
Box 44

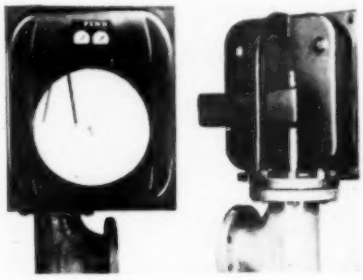
What's New!



Filter-drier Has over 24 sq. ft. Of Area, an Increase of 37%

. . . over previous models of the same design. Using a disposable filter cartridge, the new Model A-100-D "Condensifilter" is for filtering and dehydrating compressed air. When the filter becomes dirty, the entire cartridge of wire mesh and flannel cloth is replaced by removing a single nut at the top of the case. Under normal conditions, the unit will operate five to six months without renewing the filter. The condensing unit provides more than 950 sq. in. of surface area for cooling the compressed air. The dewpoint is lowered to within two or three degrees of the temperature of the cooling water used. Water and oil, in both entrained and vaporized states, are removed by condensation. A snap-action, spring-loaded trap permits discharge of accumulated condensate. Hankison Corp., 236 Biltmore Bldg., 951 Banksvile Rd., Pittsburgh, Penna.

Circle No. **22** *on Reply Card*



Variable Area Flow Meter Has Linear Air Output Signal

. . . with range of 3 to 15 psi. standard. "Linameter" is mounted directly in the pipe line like a valve and measures flow rate of liquids, vapors or gases from 0.3 to 3 gpm minimum to 120 to 1200 gpm maximum flow range. A metering float rides vertically up and down in a tapered metal metering throat inside the unit housing. Connection between metering float inside the flow stream and instrument components outside is magnetic with no stuffing boxes or pressure tight bearings. The apparatus is said to be especially suitable for use in hazardous areas, since it requires no electric power. Penn Industrial Corp., 4110 Haverford Ave., Philadelphia 4, Pa.

Circle No. **23** *on Reply Card*

Trade Literature

Catalytic Cracking

. . . by the Houdriflow process; a record of operations in ten commercial installations over the past two years, with tables showing typical yields and operating data, a description of the process and a cut-away drawing of a Houdriflow unit. Houdry Process Corp., 1528 Walnut St., Philadelphia 2, Penna.

Circle No. **24** *on Reply Card*

Chlorosulfonic Acid

. . . properties, reactions and applications; 12 page *Technical Bulletin* 0-96 reviews typical reactions with inorganic and organic compounds, including its use as a sulfonating or chlorosulfonating agent and as a catalyst in production of dye intermediates, synthetic detergents, emulsifiers and alkylated benzenes. Monsanto Chemical Co., Organic Chemicals Div., St. Louis, Mo.

Circle No. **25** *on Reply Card*

New French Refinery

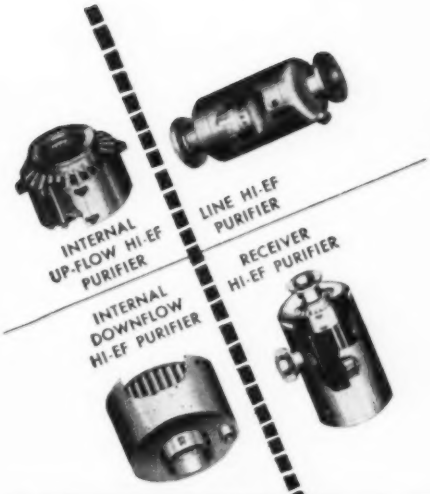
. . . of the Anglo-Iranian Oil Co. is described in a new booklet, *Lummus at Dunkirk*, showing construction and completed plant. The Lummus Co., 385 Madison Ave., New York 17, N. Y.

Circle No. **26** *on Reply Card*

Ethylene Oxide, Glycol

. . . production; booklet details Shell process with formulas, propertes, reactants, schematic flow diagram, and cost and ultilities table. The Lummus Co., 385 Madison Ave., New York 17, N. Y.

Circle No. **27** *on Reply Card*



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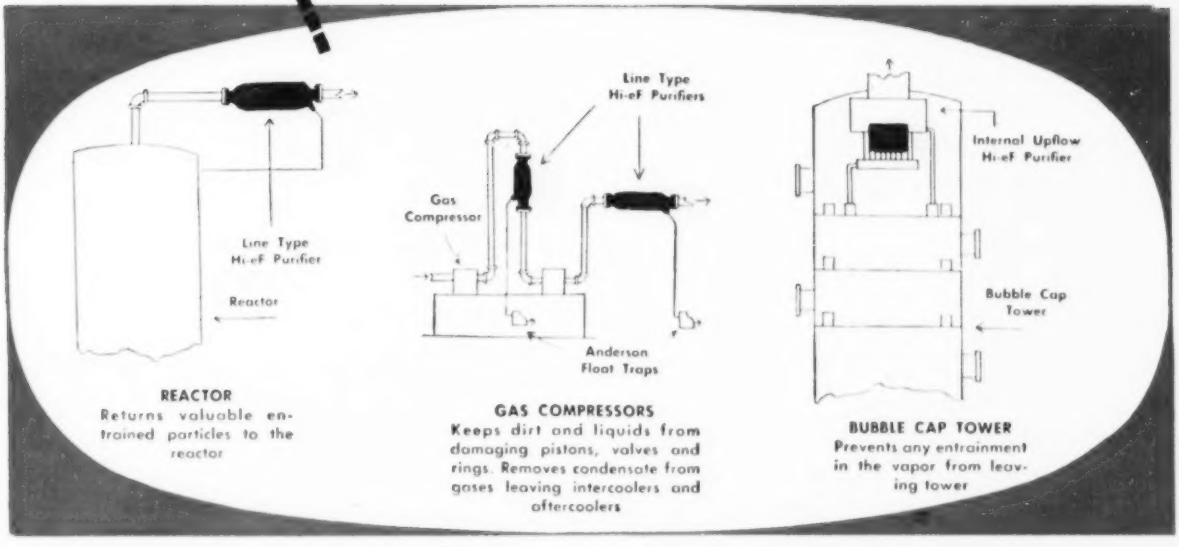

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Returns valuable entrained particles to the reactor

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Keeps dirt and liquids from damaging pistons, valves and rings. Removes condensate from gases leaving intercoolers and aftercoolers

BUBBLE CAP TOWER
Prevents any entrainment in the vapor from leaving tower

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Circle No. **28** *on Reply Card*

Rubber Linings

. . . for pipes and vessels containing corrosives; 8-page bulletin with tables on resistance characteristics of "MW" rubber lining to inorganic acids, salts and alkalies, and organic materials. Types of linings available are listed. Protective Coatings Division, Metalweld, Inc., Scotts Lane & Abbotsford Ave., Philadelphia 29, Pa.

Circle No. **29** *on Reply Card*

Recording Potentiometers

. . . covered in three 4-page specification sheets; *Specification Sheet* 160 describes circular chart recorders; *Specification Sheets* 164 and 165 describe single and multiple record strip chart recorders. Construction and engineering details included. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **30** *on Reply Card*

Spectrophotometers

. . . of both the visible and ultraviolet types; data on optics, electronics and mechanics of the units, as well as an illustrated list of available accessories with latest prices in *Bulletin* 303. Beckman Instruments, Inc., South Pasadena, Calif.

Circle No. **31** *on Reply Card*

Pressure Regulators

. . . in *Bulletin* 4003; gives performance curves on five series of "Nullmatic" pressure regulators; photographs and schematic drawings. Moore Products Co., H & Lycoming Sts., Philadelphia 24, Penna.

Circle No. **32** *on Reply Card*

Autoclaves

. . . for high temperature-pressure reactions; 48-page *Catalog* 2413 explains necessary safety measures, analyses various possible heating systems, discusses materials of construction, types of agitation and instrumentation. Blaw-Knox Co., Process Equipment Dept., Farmers Bank Bldg., Pittsburgh 22, Penna.

Circle No. **33** *on Reply Card*

Self-Cleaning Strainers

. . . 12 page booklet, showing drawings and operating capacities of three types of automatic and manually operated strainers; includes illustrations and specifications of stainless steel cones and porcelain discs now available. S. P. Kinney Engineers, Inc.. Carnegie, Penna.

Circle No. **34** *on Reply Card*

Metal Hose Data

. . . in *TD Book U-111*; information on application, temperature ranges of various types of metal and wire-braided hoses, dimensions, couplings, assemblies, etc. Universal Metal Hose Co., 2133 South Kedzie Ave., Chicago 23, Ill.

Circle No. **35** *on Reply Card*

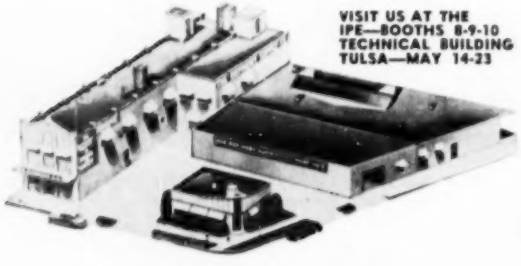
"Gagetron" Level Control

. . . via gamma rays, without electrical or mechanical connections through vessel wall; specifications and installation drawings in *Bulletin GA* 353. Instruments, Inc., 122 N. Madison, Tulsa, Oklahoma.

Circle No. **36** *on Reply Card*

Centrifugal Pump Data

. . . on single-stage, double-suction (Type S) pumps, in 66 standard sizes; with explanation of how to fig-



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ure pumping head, tables of sizes, dimensions, head capacities, and friction loss for water per 100 ft. of pipe. *Bulletin* 08B6146B. Allis-Chalmers Mfg. Co., 836 S. 70th St., Milwaukee, Wis.

Circle No. **37** *on Reply Card*

Radioisotope Use

. . . in the petroleum industry; 24 page survey of radioactive materials used currently in prospecting, production, refining, transportation, and research. Refining applications include measurement of large flow rates, determination of leak locations, study of fractionating tower performance, etc. Tracerlab, Inc., 130 High St., Boston 10, Mass.

Circle No. **38** *on Reply Card*

Indicating Flow Meter

. . . *Manual* 18*A*: application, construction and installation of Meriam Model A-286 Type H indicating flow meter; explains principles of orifice metering and pictures recommended orifice flanges. Meriam Instrument Co., 10920 Madison Ave., Cleveland, Ohio.

Circle No. **39** *on Reply Card*

Motor and Centrifugal Pump

. . . combination, magnetically driven, requiring no mechanical seals or stuffing boxes; 4-page *Bulletin G* 1000 contains dimension drawings, vacuum performance charts and performance curves on all models. Chempump Corp., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. **40** *on Reply Card*

Lindane Insecticide

. . . 28 page report; discussing properties, toxicity, formulation and uses of the gamma isomer of benzene hexachloride now in production under name "Ethyl Lindane". Ethyl Corp., 100 Park Ave., New York 17, N. Y.

Circle No. **41** *on Reply Card*

Liquid Level Control

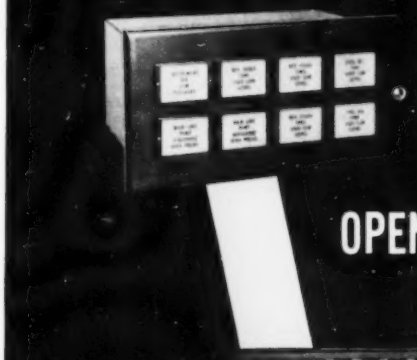
. . . operating from a single electronic type probe; described in four-page folder, *Form LLA-453*; illustrates the single electronic control, the probe, and alternative schematic arrangements for installation. Specifications are included. Thermo Instruments Co., 1166 El Camino Real, Belmont, Calif.

Circle No. **42** *on Reply Card*

Aluminum Floor Gratings

. . . and stair and ladder treads; described in two 4-page bulletins specifying various types of high corrosion resistance flooring now available. Washington Aluminum Co., Baltimore 29, Md.

Circle No. **43** *on Reply Card*



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LOOK inside the new Universal PANALARM "50". You will realize that here, at last, is an annunciator system built for *long term* dependability and service. Built to match the responsibility an annunciator must assume in your plant.

The PANALARM "50" Cabinet has a substantial hinged door . . . with sub-door to allow easy access to signal lamps. It has a new, rugged chassis design . . . pre-wired to handle any standard audio-visual signal requirement . . . and so flexible that signal sequences can be changed by simple terminal connections. No re-wiring is needed.

All moving parts and contacts of the PANALARM "50" are within hermetically sealed, plug-in units. They are corrosion-proof and suitable for Class I, Div. 2 locations. All connections are made to a single terminal block . . . with ample space for wiring.

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Ask for Catalog 100-1

PANALARM

PANALARM PRODUCTS, INC.

6312 North Broadway, Chicago 40, Illinois

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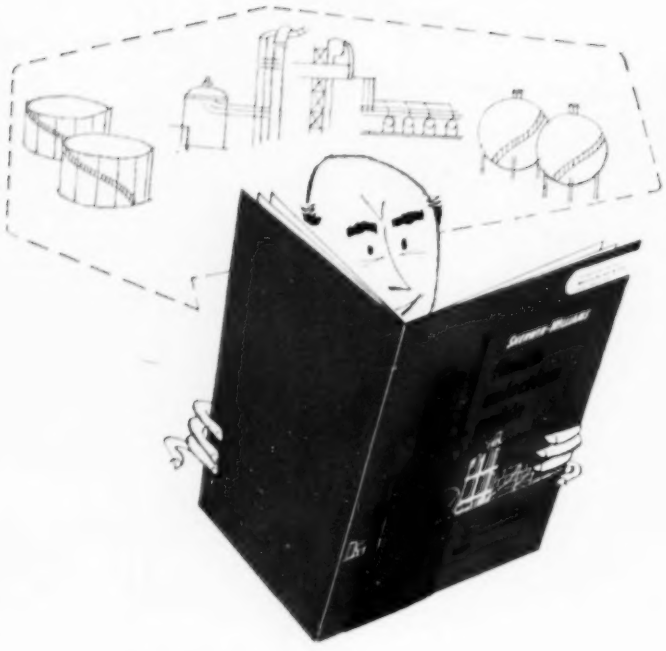


quick answers

to refinery painting problems

new guide tells WHAT paints to use WHERE!

Here's practical, convenient help in selecting the right refinery finishes—for decoration and protection of all types of surfaces, from floors to refractionating towers. It's the most complete book on the subject Sherwin-Williams has ever published.

An important feature is a 6-page check chart, which tells *at a glance* what finishes to use for each refinery structure, for each structural material. The recommendations are based on extensive refinery applications through many years, under all types of operating conditions. Included are suggestions on proper surface preparation, steps to take in painting, what to avoid. It's fitted to your needs, to your methods.

Ask for your copy. Write for Brochure B-770. Or write The Sherwin-Williams Co., Petroleum Division, Cleveland 1, Ohio.

SHERWIN-WILLIAMS

PETROLEUM FINISHES

What's New!

High Pressure Closures

. . . in 2,000-4,000 psi range; a comparison of the ASME and API-ASME pressure vessel codes; and how to select heat exchanger materials are the subjects of three articles in 36-page *Alco Products Review*, Spring, 1953 edition. American Locomotive Co., Schenectady 5, N. Y.

Circle No. **44** *on Reply Card*

Spiral-Wound Gaskets

. . . said to provide maintenance economies when used in ring-type joints; four-page folder gives dimensions and corresponding list prices. Flexitallic Gasket Co., Eighth and Bailey Sts., Camden 2, N. J.

Circle No. **45** *on Reply Card*

Non-Metallic Disc Valves

. . . *Circular* 558; listing "NMD" valve types which can be renewed or converted by insertion of specifically designed composition discs, made for handling saturated steam; for cold water, air and gas; or for gasoline, oil, butane and propane. The Lunkenheimer Co., Box 360-U, Cincinnati 14, Ohio.

Circle No. **46** *on Reply Card*

Industrial Control Systems

. . . in 80 page *Catalog* 8305; specifications, application data on non-indicating electric, electronic and pneumatic controllers for temperature, pressure and humidity, also automatic valves, switches and relays. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **47** *on Reply Card*

Bellows-Sealed Fuel Valves

. . . specially designed for volatile and toxic mediums; *Specification Sheet* 424 gives data on size, construction, materials and mounting dimensions. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **48** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of PETROLEM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

(To obtain more data on advertised products see page 768*)*

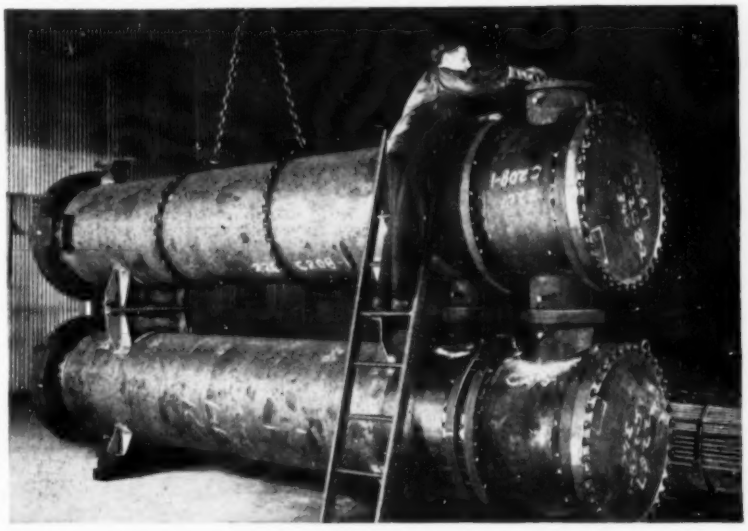
PROCESS EQUIPMENT NEWS

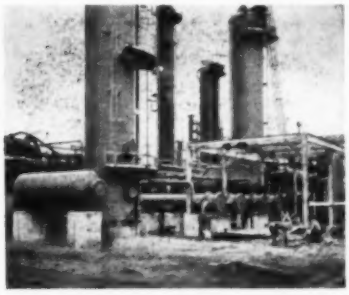
PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY MAY 1953

Special Units Developed for Sasol Project

In connection with Kellogg's work on the gasoline-from-coal synthesis plant for SASOL in South Africa, a special heat exchanger has been designed for preheating gases from the coal-gasification unit against reaction gas from the reformer.

Five of these units, each capable of operating under temperatures 1775°F and pressures of 365 psi are now being fabricated. Kellogg's extensive experience with the fabrication of hi-pressure—hi-temperature equipment—was a major reason for the decision to fabricate these critical exchangers for this process in the Kellogg plants.





More than 100 Exchangers for Eastern Refinery

Progress photo of sulfur removal unit shows just three of the many types of exchangers included in this one order. Balance of more than 100 units include complete heat exchange requirements for atmospheric distillation, Fluid cat cracking and vapor recovery facilities.

Multi-Section Naphtha Cooler Furnished for Eastern Refinery

One of several units now being fabricated for a major independent refiner, this debutanizer bottoms cooler is shown here as it is being stacked in the Kellogg plant preparatory to final machining of nozzles. This is done so that when the unit is set up in the field, no further adjustments are necessary.

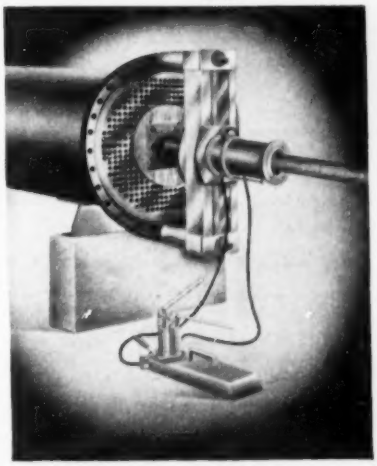
The unit is constructed using naval brass tube sheets, Admiralty metal tubes, $\frac{3}{4}$ inch, 16 BWG, 16 feet long, arranged on a 1" square pitch. Baffles, floating head cover, channel, shell and channel cover are of carbon steel. In service, the equipment will handle 278,947 lbs. per hour of naphtha on the shell side, reducing its temperature from 290°F to 100°F. On the tube side, 1933 GPM of water is used, the water being raised from 90°F to 120°F.

Kellogg has constructed this unit in accordance with its general practice, namely: TEMA standards and, in addition, the 1950 ASME Unfired Pressure Vessel Code.

For further information, details of methods, etc. contact
FABRICATED PRODUCTS DIVISION
THE
M. W. KELLOGG
COMPANY
225 Broadway, New York 7, N. Y.
or offices in Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London & Paris
KELLOGG PULLMAN

Unique Hydro-Ejector Wins Support of Maintenance Men

Sales of this new hydraulic device for removing tube bundles from exchangers are growing steadily both here and abroad, as maintenance men in refineries and other chemical processing plants continue to discover the Hydro-Ejector's many advantages. It is readily portable by *one* man, it pulls bundles faster, is safer for crews, eliminates costly rigging, and in new installations saves material amounts of structural steelwork. Using the device, two men can handle even the largest bundles . . . experience proving that it takes less than 25 minutes to push any sized bundle out eight feet. The Hydro-Ejector can exert a force of 12,000 pounds, sufficient to overcome dirt formations that cause many bundles to stick.



Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data offered in this issue's advertisements

ADDITIVE, anti-gumming & rust-inhibiting, for fuel oil: Information and sample; Oronite Chemical Co. See adv't p. 642.

ADDITIVES, aviation gasoline inhibitors: Technical bulletin SC:52-32; Shell Chemical Corp. See adv't p. 727.

ADDITIVES, gasoline: Booklets on Tenamene gum inhibitors; Eastman Chemical Products, Inc. See adv't p. 663.

ADDITIVES, lube oils for corrosion inhibiting in storage, Santolene H: Technical bulletin 0-87; Monsanto Chemical Co. See adv't p. 668.

AIR PREHEATERS: Complete details; The Air Preheater Corp. See adv't p. 636.

ALLOY TUBING: Information; Haynes Stellite Co. See adv't p. 674.

ALUMINUM BRONZES, corrosion-resistant: Information; Ampco Metal, Inc. See adv't pp. 650-651.

AUTOMATIC BLENDING: Folder; Bowser, Inc. See adv't p. 744.

ANNUNCIATOR SYSTEM: Catalog 100-1; Panalarm Products, Inc. See adv't p. 779.

BUBBLE CAPS, alloy: Process Equipment Catalog 52; The Pressed Steel Co. See adv't p. 648.

CATALYTIC REFORMING: Detailed bulletin; The Atlantic Refining Co. See adv't pp. 672-673.

CHEMICALS: "Buyers Guide"; General Chemical Div. Allied Chemical & Dye Corp. See adv't Inside Back Cover.

CHEMICALS, complete listing: Detailed information; Hooker Electrochemical Co. See adv't facing p. 744.

COMPRESSORS, turbo-charged gas engine driven: Bulletin 130; Clark Bros. Co. See adv't pp. 632-633.

COMPUTERS, electric, for problem analysis: Information; Engineering Research Associates. See adv't pp. 774-775.

CONVEYOR FLIGHTS, for dryers: Process Equipment Catalog 52; The Pressed Steel Co. See adv't p. 648.

COOLING TOWER FANS, corrosion resistant: Bulletin 1503; Hartzell Propeller Fan Co. See adv't p. 618.

CORROSION CONTROL, and bacterial-algae growth reduction: Technical bulletin E-6 and samples; Armour and Co. See adv't p. 649.

CORROSION INHIBITORS, for process equipment: Bulletin No. 189; Hercules Powder Co. See adv't p. 625.

DISTILLATION TRAYS, turbogrid design: Information; Shell Development Co. See adv't p. 656.

ELECTRIC MOTOR WINDINGS, asbestos-protected: Bulletin; U. S. Electrical Motors, Inc. See adv't p. 761.

ENGINE DEPOSITS, Booklet, "The Mechanism of Combustion Chamber Deposit Formation with Leaded Fuels"; E. I. Du Pont de Nemours & Co., Inc. See adv't p. 734.

ENGINEERING & CONSTRUCTION, of refineries: Brochure; The Lummus Co. See adv't p. 635.

EXPANSION JOINTS: Bulletin 351; Zallea Brothers. See adv't p. 667.

EXPANSION ROOF TANKS, positive seal type: 16-page booklet; Graver Tank & Mfg. Co., Inc. See adv't p. 626.

FILTERS, electric welded: Bulletin No. 1152; Ronningen Mfg. Co. See adv't p. 774.

FITTINGS, welding: Catalog W-3; Bonney Forge & Tool Works. See adv't p. 643.

FITTINGS, welding, seamless: Catalog; Globe Steel Tubes Co. See adv't facing p. 712.

GASHOLDER, dry seal: Bulletin; General American Transportation Corp. See adv't p. 657.

HAND PUMPS, for liquid: Catalog HP 206 and prices; Blackmer Pump Co. See adv't p. 742.

HEAT EXCHANGER, air-cooled type: Details; The Griscom-Russell Co. See adv't p. 679.

HEAT EXCHANGER, brazed aluminum: Bulletin, "Extended Surface Heat Transfer Equipment"; The Trane Co. See adv't p. 637.

HEAT EXCHANGER TUBES, brass and alloys: Publication B-2; The American Brass Co. See adv't p. 669.

HEAT EXCHANGE UNITS, evaporative cooler type: Catalog No. 1952; Young Radiator Co. See adv't p. 756.

INDUSTRIAL TELEVISION, for process monitoring: Bulletin 1025B; Diamond Power Specialty Corp. See adv't p. 751.

INSTRUMENT CHARTS: Catalog; Technical Charts Inc. See adv't p. 733.

INSTRUMENTATION, graphic panels: Bulletin 85-20; Minneapolis Honeywell Regulator Co. See adv't pp. 658-659.

INSULATION, finishing cement, quick setting: Full details; Forty-Eight Insulations, Inc. See adv't p. 730.

METAL FABRICATION of process equipment: Answers to specific problems; American Locomotive Co. See adv't pp. 654-655.

MIXERS, top and side entering: Catalog; Mixing Equipment Co., Inc. See adv't p. 682.

PAINT, for wire fence: Information; Rust-Oleum Corp. See adv't p. 760.

PAINT SELECTION GUIDE: Brochure B-770; The Sherwin-Williams Co. See adv't p. 780.

PIPE, steel, Saran-lined, corrosion-resistant: Catalog on Pipe, Valves and Fittings; Saran Lined Pipe Co., a Div. of Dow Chemical Co. See adv't p. 738.

PIPING, alloy, for petrochemical processing: Process Equipment Catalog 52; The Pressed Steel Co. See adv't p. 648.

PLANT STREAM ANALYZER: Bulletin 36; Process Controls Div. of Baird Associates, Inc. See adv't p. 752.

POTENTIOMETERS, electronic: Bulletin 427-1; The Foxboro Co. See adv't p. 675.

PRESSURE CONTROLS: Complete catalog; Black, Sivalls & Bryson, Inc. See adv't p. 749.

PUMPS, vertical, centrifugal: Bulletin B-53; Johnston Pump Co. See adv't p. 652.

PURIFIERS, to stop entrainment losses: Bulletins; The V. D. Anderson Co. See adv't p. 777.

REFINERY CONSTRUCTION & ENGINEERING: Brochure; Refinery Engineering Co. See adv't pp. 638-639.

SCIENTIFIC INSTRUMENTS, laboratory type: Bulletin No. 50; Refinery Supply Co. See adv't p. 778.

STEAM GENERATORS, two-drum: Bulletin; Henry Vogt Machine Co. See adv't p. 646.

STEAM TRAPS, general: Bulletin 152; W. H. Nicholson & Co. See adv't p. 744.

STEAM TRAPS, impulse type: Free trial sample for in-plant testing; Yarnall-Waring Co. See adv't p. 762.

STORAGE TANK CLEANING: Booklet; Oakite Products, Inc. See adv't p. 742.

STUDS AND NUTS, continuous thread, quenched-carbon steel: Information; Bethlehem Steel Co. See adv't p. 676.

TEL ANALYZER, flame photometer: Data File 36-155; Beckman Instruments, Inc. See adv't p. 754.

THERMOMETERS, mercury-actuated: Catalog 200-G; Palmer Thermometers, Inc. See adv't p. 761.

TOWER CLEANING, with chemicals: Information: Dowell Inc. See adv't p. 666.

TUBE FITTINGS, for high vacuum: Information; Crawford Fitting Co. See adv't p.736.

TURBINES, gear, close-coupled: Book B-4346; Westinghouse Electric Corp. See adv't p. 745.

VALVES, gate: Crane catalog; Crane Co. See adv't p. 681.

VISCOSITY CONTROL, automatic, ultra-sonic: Information; Bendix Aviation Corp. See adv't p. 758.

WATER CHILLERS: Details; Servel, Inc. See adv't p. 783.

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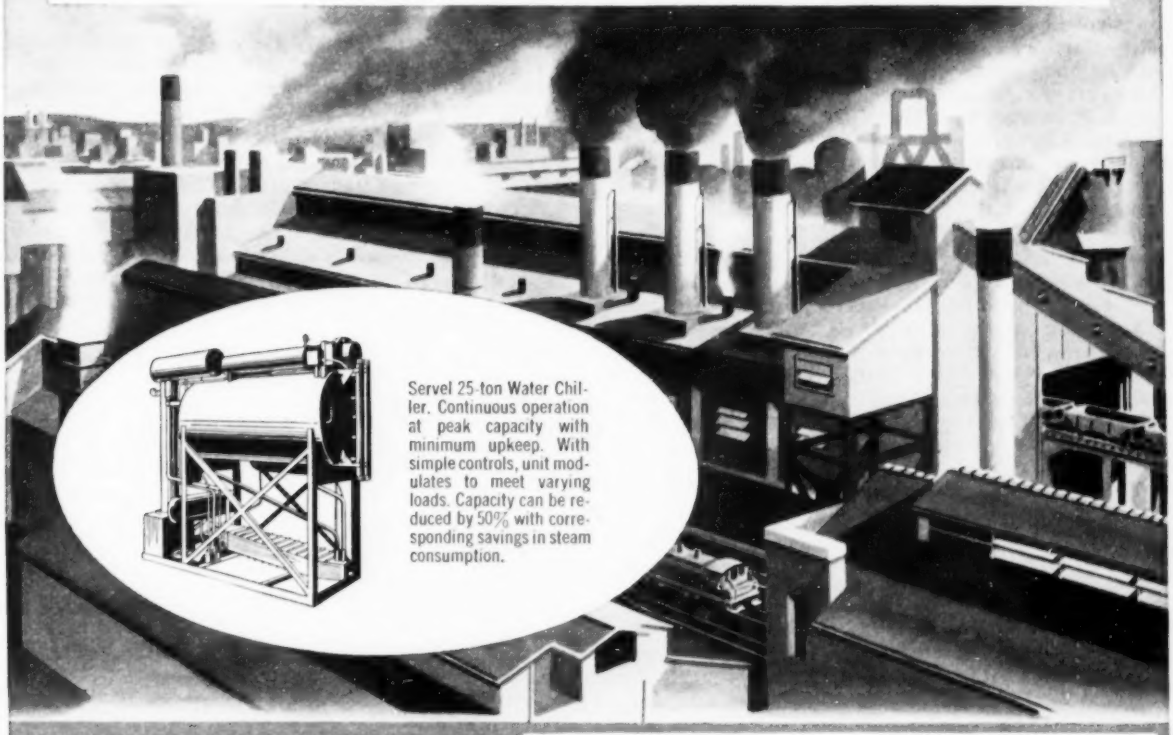

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EDITORIALS

What Will Defense Stretch-Out Mean to Petroleum Refiners?

THE REFINING industry, like other essential businesses in the country, today is in the position of a track athlete who started out in a sprint contest and then, without a rest, finds himself engaged in a long distance run.

Since the start of the Korean war, refiners have been geared to a high rate of operations and they have had before them security goals of expanded plant capacity, aviation gasoline output and other efforts. These were logically considered necessary to meet both growing domestic demand and to be prepared for a sudden widening of the shooting war. These goals have been fairly well met and at considerable burden to the oil companies.

It is now accepted that our national defense planning has to be readjusted to a continuous preparedness effort, extending perhaps many years into the future. Readying for the long pull must now replace the spurt of industrial activity that started with Korea. President Eisenhower emphasized the change when he said, recently, that the West's rearmament program must move forward on a plateau of long sustained effort, avoiding alike the peaks and valleys of exertion.

This stretching of the defense program calls for sound planning, to lessen the strain on the oil companies insofar as is compatible with our national safety. P. C. Spencer, president of Sinclair Oil Corp., brought this matter to public attention in an address before the recent meeting of the National Petroleum Assn. in Cleveland. He referred to a statement from the Defense Mobilizer to the effect that a large job still lies ahead for the petroleum industry in building an adequate reserve capacity, not only for the production of crude oil but also for refining, transportation and storage of oil and its products. To the full extent that strategic consideration require the creation and maintenance of large surplus capacities for use only in case of war, they must be provided, said Mr. Spencer.

However, he continued: "The vital question is how to do this without killing the goose that lays the golden egg—without creating a Frankenstein monster that will devour the industry in the doing."

Coming down to the situation confronting refiners today, Mr. Spencer stated that we have an overall surplus refining capacity of 800,000 to 1,000,000 bbls. On the basis of current runs to stills, the surplus is close to the latter figure, or about 13% of present total operable capacity. This total capacity is under the PAD goal of basic refining capacity for the country recommended for 1953. However, the present surplus is sufficient that in some markets the refiner's margin is threatened. PAD's latest estimate of total plant capacity needed by the end of 1953, for security purposes, is 8,125,000 bbls., excluding capacity needed to supply products especially needed by the military. This would be about 1,300,000 bbls. more than the current rate of operations.

Refiners of the nation have assumed a large financial burden in enlarging the capacity of their plants to the present figure. As President Spencer stated: "If present excess facilities overhanging the market were to be increased substantially without regard to market stability, the situation would be grave indeed."

The stretching out of our defense planning, and the reappraisal of the oil industry's required contribution to national security, poses new problems for the industry. Not the least of these is for the refining industry to maintain a rate of growth in balance with sound operating conditions. By so doing, if unhampered by government controls, refiners will best be fitted to meet what emergencies the future may bring.

—V.B.G.

Poor Climate for Scientists

MANY scientists over the country will be apprehensive until the inference in the Weeks-Astin controversy, that the findings in the battery rejuvenation study made by the National Bureau of Standards had something to do with the dismissal of Director Astin by Secretary of Commerce Weeks, is definitely cleared up. The true value of research work is greatly impaired if investigators feel any pressure, or suspicion of pressure on them, to bring out a report based on anything other than their honest, impartial assembling and interpretation of the facts.

Industry has long since learned that research can function effectively only in an atmosphere of mental freedom from the investigators. There may be other issues involved in the controversy; such as whether high technical positions in the government are going to be subject to political pressure with a change of Administration, or whether the particular study involved was the proper sort of investigative work for the Standards Bureau.

However, these matters are incidental to the main issue—can a government research investigation be put under pressure from any source to render the "right" kind of a report. The government today is too big a sponsor of research in its own bureaus and outside institutions to let any doubt stand on this matter.

—V.B.G.

Engineer Bottleneck in '55

THE larger number of engineering students going into the ROTC, and thence into military service, will cut down the number of engineering graduates available to industry in coming years, further accentuating the shortage of this professional talent. The Engineering Manpower Commission of the Engineers Joint Council foresees the greatest stringency in 1955, with 12,000 ROTC graduates buttonholed for the military and 10,000 available for all other purposes. Industrial and governmental civilian needs are placed at 30,000 engineers per year for the next decade.

EMC plans to alert graduate engineers, soon to leave the Military Services, as they can be located, on the need for them in the industrial and civilian defense field. The oil companies could supplement this program, to make sure that the opportunities they can offer technologists are fresh in the minds of even their own men as they come out of the Services.

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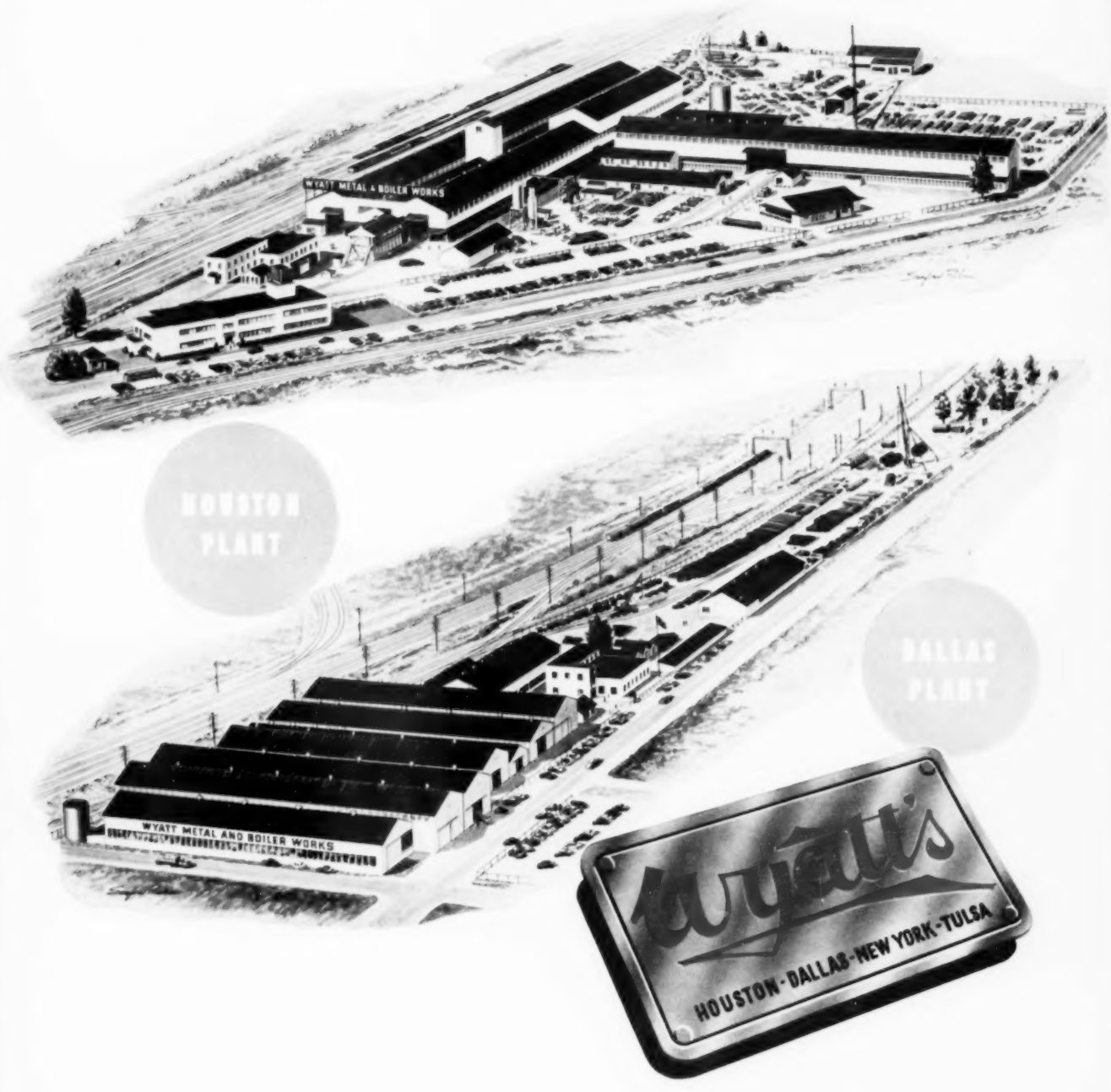

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